School of Physiotherapy and Exercise Science

Diet and attitudes among overweight and obese adolescents before, during and after participation in Curtin University’s Activity, Food and Attitudes Program

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Results of this thesis have been presented in part by the candidate, in the following publications and at the following scientific meetings:


SIGNATURE: _________________________________________________________

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Acknowledgements

“How often in life we complete a task that was beyond the capability of the person we were when we started it” - Robert Brault

I began this PhD after working in clinical dietetics for a number of years. I had been involved in the development and piloting of CAFAP since the inception of the program. When our team received the Healthway grant, I knew I couldn’t just give away the nutrition component for someone else to evaluate. I am forever thankful that I have had the opportunity to experience such personal and professional growth as a result of completing this PhD. I am so proud of myself for doing this.

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Abstract

Aim

Adolescent obesity has been identified as a significant public health concern. Standard treatment of adolescent obesity includes multi-component interventions targeting adolescents and their families. However, despite the high prevalence of adolescent obesity, there is very little evidence to inform the design of such obesity interventions. This lack of evidence extends from the development of intervention and maintenance programs, through to processes to engage and retain adolescents and families in treatment. Further, there is a lack of detailed reporting of behaviour change following obesity intervention, particularly regarding dietary change. Stronger evidence is needed to improve the development, delivery and evaluation of adolescent obesity interventions. Against this background, the aim of this thesis was to explore the diets and attitudes among overweight and obese adolescents before, during and after participation in Curtin University’s Activity, Food and Attitudes Program. The specific objectives of this thesis were:

1) To investigate the perceptions of adolescents, parents and stakeholders regarding barriers and facilitators to recruitment, retention and maintenance associated with a healthy lifestyle program

2) To examine the patterns of dietary intake for obese adolescents entering a healthy lifestyle program

3) To provide a detailed description of the development of the dietary component of Curtin University’s Activity, Food and Attitudes Program (CAFAP)

4) To assess adolescent dietary change for food groups, energy intake, nutrients, eating behaviours and adherence from immediately post-intervention to 12 months post-intervention

5) To evaluate the experiences of adolescents receiving text messaging support during the maintenance period
Methods

The five studies in this thesis examined findings related to the dietary components of a broader research project evaluating an adolescent obesity intervention conducted in communities across Western Australia in 2012-2013. The intervention was a multi-disciplinary, multi-component, family-based intervention known as Curtin University’s Activity, Food and Attitudes Program (CAFAP). The research project occurred in two stages. The first stage was a period of formative research and the second stage involved the delivery and evaluation of CAFAP.

The first stage of the research project involved a review of the previously delivered pilot version of CAFAP and engagement of local communities to support the future delivery of CAFAP. This stage included focus groups with past participants (five adolescents and eight parents) and potential participants (39 adolescents and four parents). In addition, in-depth interviews were completed with 39 community stakeholders. The key topics for the focus groups and interviews centred on the recruitment of adolescents and parents, retention in the program and maintenance of healthy behaviour change following the program. Data were analysed using content and thematic analyses.

The second stage included the delivery and evaluation of CAFAP. The study design was a staggered entry, within-subject, waitlist-controlled clinical trial. CAFAP was delivered as an eight week intervention, based on self-determination theory and goal setting theory. CAFAP was followed by a 12 month maintenance period of telephone and text message contact. This contact was offered at a reducing frequency over the 12 month period. Overweight adolescents (n = 69, 71% female, mean age 14.1 (SD 1.6) years) and their parents enrolled in the intervention. Adolescents and parents completed assessments at baseline, immediately prior to starting the intervention, immediately following the intervention, and at three-, six- and 12-months following the intervention. Diet was assessed using three day food records and a short eating behaviour questionnaire.

Dietary intake at baseline was separated into intakes of fruit, vegetables and junk food, of which junk food was further split into fast food, sugar-sweetened
beverages and other junk. Negative binomial and binary logistic regression using generalised estimating equations were used to compare the amount and likelihood of consumption of each food group between time periods.

Dietary change following participation in CAFAP was assessed by comparing diet at all assessment points to baseline dietary measures. This included aspects of energy intake, food group intake, nutrient intake and frequency of engaging in key eating behaviours. The adherence to the dietary intervention key messages was assessed immediately post-intervention and 12 months post-intervention. Adherence was measured by the percentage of adolescents who reported changes to their diet in line with the three key dietary intervention messages (eat more fruit, eat more vegetables, eat less junk food).

The adolescent experience of the text messaging support during the first three months of the maintenance period was explored using focus groups. Adolescents (n=12) and parents (n=13) provided opinions about their experience of the three weekly text messages, which were based on the theory underpinning CAFAP. Participants were asked about the usefulness and acceptability of text messages, as well as opportunities to improve the text messaging support. Data were analysed using content and thematic analyses.

Results

The findings of the formative research period highlighted a number of barriers and enablers relating to recruitment, retention and maintenance in adolescent obesity interventions. Participants described barriers specific to adolescents and parents that would have to be considered by researchers and health professionals at all stages of the intervention. These included weight stigma, issues with timing and location, and lack of existing services to support healthy change. As an enabler, all participants reiterated the importance of engaging local communities in the development and delivery of obesity interventions.

At baseline, adolescent intake was characterised by low intakes of fruits and vegetables and high intakes of junk food. For girls and boys, intake of fruit,
vegetables and junk food showed patterns of intake which differed by time of day
and day of week. For example, overweight adolescent girls were more likely to eat
fruit on weekdays than weekends (odds ratio=5.0, p<.001) and overweight boys’
fast food intake increased overall on the weekend (incidence rate ratio (IRR) = 3.6,
p=.001).

Following participation in CAFAP, overweight adolescents increased their daily
intake of fruit (0.5 servings, monthly IRR 1.3, 95% CI: 1.10, 1.56) and reduced their
intake of junk food (1.4 servings, monthly IRR 0.8, 95% CI: 0.74, 0.94). Intake of
vegetables did not change. Adherence to the key dietary intervention messages
were highest for ‘eat less junk food’ (69% post intervention) and lowest for ‘eat
more vegetables’ (49% post intervention). There were no reported changes in
eating behaviours or energy intake following the intervention. Nutrient changes
included a reduction in fat (p=.002) and saturated fat intake (p=.001), along with an
increase in fibre intake (p=.016).

During the 12 month maintenance period fruit intake remained improved from
baseline at each time point. Vegetable intake improved at six months post-
intervention but this was not maintained at 12 months post-intervention. Junk food
remained reduced from baseline up to six months post-intervention. At 12 months
post-intervention ‘eat less junk food’ remained the dietary intervention message
most adhered to (60%) and ‘eat more vegetables’ remained the message least
adhered to (40%). Self-reported improvements in eating behaviours occurred at
three months post-intervention for frequency of breakfast consumption (p=.008).
There was a reduction in the frequency of consumption of fast food at three-, six-
and 12 months post-intervention and for sugar-sweetened beverages at six- and 12
months post-intervention. Energy intake did not change during the maintenance
period and nutrient intakes appeared to regress towards baseline levels.
Micronutrient intake did not change during the intervention or maintenance
periods.

Obese adolescents responded negatively to the text message support provided in
the first three months of the maintenance program following CAFAP. The key
themes emerging from the focus groups suggested that adolescents experienced unintended feelings of guilt and shame associated with receiving the text messages. This potentially distanced adolescents from the program and identifies the need for future interventions to distinguish between text messages designed for behaviour change and text messages designed to promote ongoing positive relationships with the program. Further, adolescents were not able to suggest ways to improve the text messages to make them more useful in the future. This highlights one of the limitations of pre-intervention testing of text messages with obese adolescents.

Conclusions

The identification of barriers and enablers for the successful delivery of adolescent obesity interventions can be used to guide the design of future interventions. The detailed patterns of consumption of key food groups showed differing patterns of intakes for overweight boys and girls. These patterns can be incorporated into future dietary interventions for overweight adolescents as targeted dietary messages. Comprehensive reporting of the diet of overweight adolescents participating in an intervention showed positive immediate changes to food group and nutrient intake but the effects diminished over time. These findings support the inclusion of comprehensive dietary assessment methods in future interventions to understand more about what overweight adolescents eat and how this changes following intervention.
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Definitions

The following definitions apply throughout this thesis:

- **Overweight**: At or above the 85th percentile for BMI-for-age-and-sex as plotted on the Centers for Disease Control and Prevention growth charts (Kuczmarski et al., 2000).
- **Obese**: At or above the 95th percentile for BMI-for-age-and-sex as plotted on the Centers for Disease Control and Prevention growth charts (Kuczmarski et al., 2000).
- **BMI or Body Mass Index**: This is a measure of body fatness. In adolescents, BMI plotted on the developmental curve of the BMI-for-age-and-sex charts is generally accepted as an appropriate measure of categorizing levels of overweight (Krebs et al., 2007). The BMI percentiles defined above also align with the International Obesity Task Force (IOTF) cut offs used in the identification of absolute overweight or obesity, although the IOTF definitions cannot be used to track changes in individual obesity levels (Cole et al., 2000, Krebs et al., 2007).
- **BMI z-scores**: This term refers to BMI standard deviation scores, which are a measure of relative weight adjusted for age and sex.
- **Diet**: This term refers to all aspects of diet including energy, food groups, nutrients and eating behaviours.
- **Energy intake**: This term refers to the kilojoules from food and beverages. This is commonly presented as a daily intake. One calorie is equivalent to 4.18 kilojoules.
- **Energy balance**: This term refers to the balance between energy intake and energy expenditure. If energy intake is greater than expenditure, a person is said to be in positive energy balance, and this can lead to weight gain over
time. If energy intake is less than expenditure, a person is said to be in negative energy balance, and this can lead to weight loss over time.

- Food groups: This term refers to the five main food groups of the Australian Guide to Healthy Eating (grain foods, fruit, vegetables and legumes, dairy and meat/meat alternatives). In addition to this, junk foods (see definition below) have been included as a food group for ease of discussing food intake.

- Nutrients: This term refers to both macronutrients (carbohydrate, fat and protein) and micronutrients (i.e. vitamins and minerals). Discussion of macronutrients will incorporate both the total (grams) and the percentage of energy provided by macronutrients.

- Eating behaviours: This term refers to behaviours that may impact diet, for example skipping breakfast or eating family meals.

- Junk food: This term refers to energy-dense, nutrient-poor foods that are not essential for good health. Such foods are not consistently classified, but reflect the ‘discretionary foods’ in the Australian Guide to Healthy Eating.

- Fast food: This term refers to highly processed food that is prepared in a standardised way and served quickly. Fast food outlets include McDonalds, Hungry Jacks/Burger King and KFC.

- Sugar-sweetened beverages: This refers to beverages that contain added sugar and contribute to kilojoule intake. This includes beverages like soft drink, soda, cordial, fruit drink, sports drink and energy drinks but excludes flavoured milk and 100% fruit juice.

- Breakfast: This term is inconsistently defined in the literature; however, in this thesis breakfast refers to a morning meal consumed before 9am.
Chapter 1.0 Introduction

1.1 Poor health outcomes associated with adolescent obesity

Overweight and obesity estimates in Australia suggest prevalence rates of around 25% in adolescents (National Health and Medical Research Council, 2013b, Australian Bureau of Statistics, 2012, Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008, Olds et al., 2009) with similar observations in other developed countries (Ogden et al., 2010, Ryley, 2013). This high prevalence of overweight and obesity in adolescents has generated significant concern amongst health professionals and researchers alike. Obesity in adolescence has been consistently linked to an increased risk of early mortality and poor health outcomes in adulthood (Reilly and Kelly, 2011). Obesity during adolescence is also related to adverse health outcomes during adolescence including hypertension, orthopaedic complications, sleep apnoea, increased risk of Type II diabetes (Baur, 2002, Steinbeck, 2005), poor self-esteem and depression (Merten et al., 2008, Strauss, 2000). Additional evidence of the tracking of obesity from adolescence to adulthood (Singh et al., 2008) highlights the need for interventions during adolescence (Story et al., 2002). Adolescence is therefore a critical period for the implementation of effective obesity prevention and management initiatives.

1.2 Diet as a potential cause of obesity

Obesity can stem from genetic and environmental origins; however the recent increase in obesity over the past several decades is reported to be most likely a result of changes to eating and activity habits in response to environmental changes (Barlow, 2007). It has been suggested that behaviours such as decreasing engagement in physical activity, increasing time spent in sedentary activities and increasing consumption of energy-dense, nutrient-poor foods have contributed to the current high rates of overweight and obesity (Baur, 2002). The aetiology of obesity is complex and multi-factorial (Davison and Birch, 2001) but poor diet is...
consistently thought to play an important role (Swinburn et al., 2009, National Health and Medical Research Council, 2013b).

Adolescent diet has been shown to differ markedly from the healthy diet outlined in the Australian Dietary Guidelines (Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008). There are a number of aspects of diet that may contribute to the poor quality of adolescent diet, including excessive energy intake, changes in food group intake, sub-optimal nutrient intake and adoption of unhealthy eating behaviours. Adolescent diets high in energy-dense, nutrient poor foods can contribute directly to energy imbalance, one of the key risk factors suggested for the development of overweight and obesity (National Health and Medical Research Council, 2013b). Consumption of these foods, such as sugar-sweetened beverages (Nelson et al., 2009) and fast food (Bauer et al., 2009), have been shown to become more prevalent from adolescence to young adulthood. High intakes of fat during adolescence has also been shown to be a significant predictor of poor quality adult diet after 21 years (Mikkila et al., 2004). Poor diet in adulthood is a risk factor that has been consistently associated with higher levels of adult mortality and morbidity, in particular increased cardiovascular disease risk (Wirt and Collins, 2009). Further, adoption of unhealthy eating behaviours during adolescence, such as skipping breakfast, have been associated with negative health outcomes (Iannotti and Wang, 2013, Institute of Medicine, 2012, Mitchell et al., 2013), independent of the presence of overweight or obesity. Interventions targeting diet during adolescence are therefore likely to have important immediate impact on diet during adolescence and these may continue into adulthood.

1.3 Importance of dietary intervention during adolescence

Dietary interventions during adolescence are well-placed to address the common decline in dietary quality between childhood and adolescence, particularly around reduced fruit and vegetable intake (Martin et al., 2008) and reduced frequency of family meals (Burgess-Champoux et al., 2009). Given the generally low quality of adolescent diets, interventions at this time are also useful to address extra nutrition requirements for cognitive, physical and social growth and development (Stang,
Diet-only and diet plus exercise interventions have both been shown to result in weight loss and a variety of metabolic improvements, highlighting the importance of including a dietary component in interventions to treat obesity (Ho et al., 2013). Recent reviews recommend a multi-disciplinary approach to intervention given the multiple contributing factors to obesity (Oude Luttikhuis et al., 2009, Whitlock et al., 2010), although the impact of different intervention components remains unclear and likely depends on the needs of the specific target group (Oude Luttikhuis et al., 2009).

Even within diet, it is difficult to separate out the impact of the different aspects of diet on the development and progression of obesity, thus the evidence for effective obesity treatment is still evolving. Dietary interventions may focus on modifying energy intake, food group intake (e.g. fruit and vegetable intake), macronutrient intake (e.g. fat intake), micronutrient intake (e.g. calcium intake), eating behaviours (e.g. skipping breakfast) or a combination of the above.

### 1.4 Gaps in knowledge about dietary interventions for overweight and obese adolescents

There is currently limited evidence to guide the design and implementation of effective interventions targeting dietary change in overweight and obese adolescents. Firstly, there are few reported details regarding how to effectively engage adolescents; from recruitment, to intervention and throughout the maintenance period. Secondly, there is insufficient evidence regarding the current diet of overweight and obese adolescents, reducing the ability of interventions to target the most relevant and changeable aspects of the diet and thus have the most impact. Thirdly, there are few detailed descriptions of the rationale, development and implementation of dietary interventions for overweight adolescents, nor how adolescents adhere to these interventions. Fourthly, there is a lack of detailed data to describe overweight adolescent dietary change following intervention, with very little consideration given to the impact of underreporting in this group. Fifthly, there is scant evidence regarding the most effective way to support overweight adolescents in their maintenance of change following intensive intervention.
Therefore the objectives of this thesis were:

1) To investigate the perceptions of adolescents, parents and stakeholders regarding barriers and facilitators to recruitment, retention and maintenance associated with a healthy lifestyle program

2) To examine the patterns of dietary intake for obese adolescents entering a healthy lifestyle program

3) To provide a detailed description of the development of the dietary component of Curtin University’s Activity, Food and Attitudes Program (CAFAP)

4) To assess adolescent dietary change for food groups, energy intake, nutrients, eating behaviours and adherence from immediately post-intervention to 12 months post-intervention

5) To evaluate the experiences of adolescents receiving text messaging support during the maintenance period

1.5 Thesis structure

To address the objectives listed, this thesis reports the results of five studies that pertain to the multi-disciplinary evaluation of a family-centred, community-based intervention (CAFAP) delivered in Western Australia. This research project comprised two main stages. Stage One was a period of formative research to refine the original pilot version of CAFAP and engage local communities. Stage Two included the multi-disciplinary delivery of CAFAP to seven cohorts of adolescents and their parents during 2012-2013. In brief, a wait-list controlled clinical trial was undertaken with each cohort being assessed before a three month wait-list period, before and after an 8 week intensive intervention, and at three, six and 12 months following intensive intervention. The 12 months following intensive intervention was treated as a maintenance period and adolescents received ongoing support including text messaging at a decreasing frequency. Figure 1.1 illustrates the research stages and the timing of the five studies reported in this thesis. The focus of these studies is on the dietary component of the intervention, and the
experiences of overweight adolescents and their parents relating to the intervention. Thus, the results presented in this thesis represent only part of the greater multi-disciplinary study.

- Study A – a qualitative study of the barriers and enablers to participation in a healthy lifestyle program, as perceived by adolescents, parents and stakeholders. This study was undertaken during Stage one and covers three major topics of recruitment, retention and maintenance and is reported in Chapter Three.

- Study B – a quantitative study of overweight adolescent intake prior to beginning a healthy lifestyle program. This Stage two study examines the consumption of fruit, vegetables and junk food by time of the day and day of the week and is reported in Chapter Four.

- Study C- a quantitative study of overweight adolescent dietary change following intervention, and maintenance of change over 12 months. This Stage two study focuses on the primary outcomes of the larger trial, specifically fruit, vegetables and junk food, and is reported in Chapter Five.

- Study D- a quantitative study reporting detailed adolescent dietary change following intervention, and maintenance of change over 12 months. This Stage two study describes dietary change in terms of energy, nutrients and eating behaviours and is reported in Chapter Six.

- Study E- a qualitative study exploring the opinions of overweight adolescents and their parents regarding the use of text messages as a support during the maintenance period following intervention. This Stage two study is reported in Chapter Seven.

Prior to reporting the details of the five studies, Chapter Two provides a review of the literature relevant to the context of the studies and includes an overview of the methods common to all studies. Following the reporting of the five studies, Chapter Eight provides an overall discussion on the aims of the thesis, limitations and strengths, clinical implications and ideas for future research. The implications for future research and practice are summarised in Chapter Nine.
Figure 1.1 Trial design and timing of corresponding studies

- **Stage 1: Formative research**
  - Chapter 3, Study A: Barriers and enablers to recruitment, retention,
  - Chapter 4, Study B: Consumption

- **Stage 2: Waitlist controlled clinical trial**
  - Chapter 5, Study C: Changes in fruit, vegetable, and junk consumption
  - Chapter 6, Study D: Changes in nutrition outcomes
  - Chapter 7, Study E: SMS experiences
Chapter 2.0 Literature review

This literature review chapter is presented in three main sections. The first part of the chapter reviews of the dietary factors associated with adolescent obesity development and a comparison of consumption habits between healthy weight and overweight adolescents. This includes a review of the dietary assessment methods used to provide this data and the associated limitations. The second part of the chapter describes the key components of multicomponent interventions for overweight adolescents and reviews how these have been incorporated into previous studies. The third part of the chapter reviews the effectiveness of multicomponent interventions with a dietary component and highlights the gaps for future research.

2.1 Adolescent diet and weight gain

Weight gain during adolescence, in excess of that associated healthy growth and development, is caused by an imbalance between energy intake and energy expenditure (National Health and Medical Research Council, 2013b). Diet is widely believed to contribute to this energy imbalance and thus is related to weight gain (Nishida et al., 2004, Swinburn et al., 2009). However, weight gain is likely impacted by a number of social, environmental, genetic and behavioural factors that obscure the exact role of diet in the development of adolescent overweight and obesity (National Health and Medical Research Council, 2013b). Whilst there are a large number of cross sectional and longitudinal studies of varying sample sizes that have investigated which aspects of diet may be related to an increased likelihood of weight gain or obesity in adolescence, the evidence is often far from conclusive due to research challenges (Berkey et al., 2000, Bradlee et al., 2010, Niemeier et al., 2006, de Gouw et al., 2010, Al-Hazzaa et al., 2012, Dupuy et al., 2011, Sun et al., 2009, Janssen et al., 2005, McClain et al., 2011, Rocandio et al., 2001, Yannakoulia et al., 2012, Patrick et al., 2004).
2.1.1 Challenges in understanding the relationship between adolescent diet and weight gain

There are a number of issues that impede research relating to the diet and weight gain relationship. In a systematic review of randomised trials in overweight adolescents, Collins et al. (2006) highlighted the difficulty in measuring only the impact of individual dietary behaviours on weight. Given there are a number of postulated contributors to obesity development and most interventions target multiple behaviours, it is often impossible to separate out the role of diet (Collins et al., 2006). Further, the inconsistent relationships reported between diet and weight gain may be related to imprecise dietary assessment measures, including limitations associated with self-reported intake, which has the potential to mask true diet-disease relationships (Forrestal, 2011) and is discussed in detail in section 2.1.4. The Dietitians Association of Australia has also acknowledged the difficulties in establishing solid evidence in a review of studies to develop dietary guidelines (Allman-Farinelli et al., 2014). This section reviews the evidence regarding the main aspects of diet commonly reported to be related to adolescent weight gain.

2.1.2 Aspects of diet related to weight gain

Whilst an association between some aspects of diet and overweight in adolescents has been identified in observational studies, there have been few adolescent intervention studies to describe the causal relationships. Hence, it remains unknown as to how different aspects of adolescent diet, such as food group intakes and eating behaviours, might contribute to obesity. Further, it remains unclear as to which of these aspects could be most effectively modified to best treat obesity in individual or group settings. Regardless, diet remains one of the main targets for obesity interventions. A recent meta-analysis in children and adolescents showed that dietary interventions do result in weight loss, but further evidence is needed regarding how to maximize the success and efficacy of dietary interventions (Ho et al., 2013). Without this evidence, interventionists can only make a “best guess” about which aspects of the diet to target. The most common aspects of diet that have been linked with overweight include the overconsumption of some food groups such as junk food, inadequate consumption of other foods groups such as
fruit and vegetables and certain eating behaviours such as skipping breakfast and these are reviewed in more detail below.

### 2.1.2.1 Overconsumption of junk foods

There is no internationally accepted term to describe and classify food and beverages that do not fit into core food groups and are considered to be energy-dense, nutrient-poor (Rangan et al., 2008). ‘Discretionary food’ is an Australian term and refers to foods that are not necessary for health and do not belong to the core food groups of grain foods, lean meats and meat alternatives, dairy, fruits and vegetables (Smith et al., 1998, Dixon et al., 2007, Rangan et al., 2008). In this thesis, this group of discretionary foods is referred to as ‘junk food’ to reflect the common terms used with families in the healthy lifestyle program from which the data for this thesis was collected. Junk food includes foods such as fast food, sugar-sweetened beverages and ‘other junk’ such as cake and crisps. Each of these will be discussed in the following sections.

#### 2.1.2.1.1 Fast food

Fast food is not defined consistently in the literature (Jeffery et al., 2006), making it difficult to compare directly between trials with different definitions. Some definitions refer to the process of obtaining fast food, for example, “food you pay for before eating” (Schmidt et al., 2005) or “food purchased in a carry-out eating place” (Pereira et al., 2005). Other definitions refer to specific fast food restaurants (Bauer et al., 2009) and others refer to the poor nutritional quality of the food (Rosenheck, 2008). In this thesis, fast food refers to highly processed food that is prepared in a standardised way and served quickly. Fast food outlets include McDonalds, Hungry Jacks/Burger King and KFC. It has been suggested that eating away from home, particularly at fast food restaurants, can lead to consumption of larger portions by adolescents and often a greater total energy intake (Ledikwe et al., 2005, Schmidt et al., 2005). The findings from a number of cross-sectional and prospective studies have provided strong support for the association between increased fast food consumption and greater levels of overweight in adults (Rosenheck, 2008). The evidence base for adolescents, however, is still evolving with the following studies suggesting an association. A large American cohort study
of adolescent females found an association between increased energy intake and increased fast food intake (Schmidt et al., 2005). This study used comprehensive dietary measures including three day food records and a food-patterns questionnaire and showed a statistically significant difference of 129 kCal daily energy intake between low and high consumers of fast food. Baseline data from a large USA longitudinal cohort study by Taveras et al. (2005a) showed that adolescent boys and girls who consumed fried food away from home were more likely to have greater energy intakes than those who did not. These authors used fried food as a proxy for fast food as there was a moderate-to-strong correlation when assessed separately. In the associated longitudinal analysis, these authors were able to show a significant increase in BMI for adolescents who went from “never or <1/week consumption” to “4 to 7/week consumption” of fried food. In a smaller longitudinal study over six years (n=101), Thompson et al. (2004) showed that adolescent girls who ate fast food more than twice a week had a greater increase in BMI than those who did not during the study period. This is concerning given a large, five year study of American adolescents (n=2156) by Bauer et al. (2009) showed secular increases in the percent of adolescents consuming fast food between 1999-2004. Longitudinal evidence from this study also suggested a trend for increased fast food consumption between early and middle adolescence for both girls and boys (Bauer et al., 2009), although this finding is based on only a single item from a questionnaire (In the past week, how often did you eat something from a fast food restaurant [like McDonald’s, Burger King, Hardee’s, etc.?]). A large prospective study of American adolescents (n=9919) showed that fast food consumption during the adolescent years could predict weight gain in early adulthood (Niemeier et al., 2006). The authors found that fast food consumption increased over the five year study period and that a greater frequency of fast food consumption at baseline predicted increased BMI z-scores at follow up. Hence, these studies provide reasonable observational evidence to suggest an association between fast food and weight gain during adolescence, highlighting fast food intake as a potentially important target for intervention.
2.1.2.1.2 Sugar sweetened beverages

Consumption of sugar-sweetened beverages (SSBs) is another behaviour often linked to weight gain. Sugar-sweetened beverages are beverages with added sugar, including soft drinks, energy drinks, sports drinks, cordial and fruit juice drinks (Rangan et al., 2008). Definitions in the literature differ as to whether SSBs include flavoured milks. The Australian classification of SSBs used in this thesis does not include flavoured milks as SSBs (Rangan et al., 2008). Although increased intake of SSBs has been associated with increased frequency of fast food consumption (Taveras et al., 2005a), a number of observational studies have found an independent link between SSBs and overweight. For example, a prospective study of more than 10,000 USA adolescents by Berkey et al. (2004) found an association between SSB consumption and weight gain. In this study, longitudinal data showed associations between consumption of SSBs and small BMI increases across one year intervals. When this model was adjusted for energy intake, the association was no longer significant; suggesting that increased consumption of SSBs may be related to increased energy intake and have the potential to contribute to a positive energy balance in adolescents. A relatively small longitudinal study of 196 adolescent girls (Phillips et al., 2004), showed that soda consumption was related to BMI z-score over a 10 year period. This study assessed soda separately to SSBs as a total category, but the findings still represent a subset of SSBs. Ludwig et al. (2001) also showed that the risk of overweight in early adolescence (n=548) increased by 1.4 times with consumption of every additional daily SSB. The authors of the latter study suggest that weight gain may result from a lack of compensation for the energy consumed in a SSB.

Despite consistent observational evidence to suggest an association between obesity development and SSB consumption, the role of SSBs in the treatment of obesity is less clear. A randomized trial of 224 adolescents by Ebbeling et al. (2012) showed that a reduction in SSB consumption in adolescents resulted in a reduced energy intake and smaller increase in BMI than in the control group after one year, but these effects were not maintained at two years post-intervention. Similar modest effects have been reported in a study of younger children (7-11 years) in a
cluster randomised controlled trial by James et al. (2004), and a large school-based randomised trial in Brazil (Sichieri et al., 2009). Overall, there are limited experimental trials indicating a causal relationship between SSBs and obesity in adolescents.

Sugar sweetened beverages also have the potential to reduce nutritional adequacy independent of obesity and total energy intake including displacing calcium-rich beverages like milk (Vartanian et al., 2007, Harnack et al., 1999). This is of particular concern given adolescents have been shown to have inadequate intakes of calcium (Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008). High SSB intakes have also previously been linked to lower intake of fruit and vegetables in Australian youth (Morley et al., 2012). Additionally, a high intake of added sugar in liquid form, such as from SSBs, has been identified as a risk factor for impaired glucose homeostasis and insulin resistance in children with an obese parent (Wang et al., 2014). Given the other associations and the relationship between SSBs and increased risk of chronic disease, reducing SSBs is an important target to reduce obesity-related health risk (Collins et al., 2013, Vartanian et al., 2007).

2.1.2.1.3 Other junk foods

Aside from fast food and SSBs, increased consumption of other junk foods such as energy-dense snacks might have the potential to contribute to positive energy balance (Piernas and Popkin, 2011b). Typically, junk food has been assessed as a single food group composed of fast food, SSB and other energy-dense nutrient poor foods, but the latter category has rarely been individually analysed despite its potential for independently contributing to poor health and obesity. Of the studies that have considered this sub-group of junk food, longitudinal evidence from a small cohort of initially non-obese girls did not show any relationship between body fatness and intake of candy, baked goods, chips or ice cream (Phillips et al., 2004). Similarly, a three year study measuring intake of snack foods (e.g., potato chips, Poptarts and donuts) in more than 14,000 children and adolescents found no evidence to support a relationship between consumption of snack foods and weight gain (Field et al., 2004). Although the authors concluded that no relationship exists,
both studies used food frequency questionnaires, from which the ‘quantification of intake is not as accurate as with recalls or records’ (Thompson and Subar, 2013). Previous research suggests that overweight adolescents are more likely to underreport their dietary intake (Lioret et al., 2011), which has been associated with less frequent reporting or omission of junk foods such as confectionaries and crisps (Murakami et al., 2012, Rangan et al., 2014). This may explain part of the lack of a demonstrated relationship between high energy junk foods and weight status in adolescents.

Other studies considering junk food intake in overweight adolescents have used a classification that potentially includes fast food and SSBs, so the findings may apply to all junk foods (Bandini et al., 1999, Keast et al., 2010). In a small cross-sectional study of healthy weight and obese adolescents, data from three day food records showed that total energy provided by high energy foods was similar between the two groups after adjusting for underreporting (Bandini et al., 1999). This is in contrast to data from the large USA National Health and Nutrition Examination Survey (1999-2004 NHANES) which showed a consistent inverse relationship between increasing percentage of energy from snacks and BMI (Keast et al., 2010). In this analysis, three NHANES data collection periods were combined and participants defined their own snacking occasions as part of a 24-hour recall. Body weight, BMI, BMI percentile and waist circumference were all found to be inversely related to percentage of energy from snacks, with or without adjustment for total energy intake. Snacking was also associated with increased total energy intake, which suggests that underreporting of snacks was not a factor in these findings. Thus, the evidence for the role of energy-dense snacks in the development or progression of obesity remains inconsistent at this stage, but suggests a positive relationship.

2.1.2.2 Inadequate consumption of fruit and vegetables
It has been hypothesised that fruits and vegetables are often displaced by energy-dense, nutrient poor foods which have been linked with increased energy consumption (Rolls et al., 2005). Thus it is suggested that eating more fruit and vegetables could lead to reduced consumption of energy-dense, nutrient poor
foods (Epstein et al., 2001) and potentially help to achieve negative energy balance in overweight and obese adolescents. However, there are few well-designed studies using appropriate dietary assessment methods to explain any relationship between fruit and vegetable consumption and overweight in adolescents. A recent systematic review showed that increased fruit and vegetable intake was related to lower levels of adiposity in overweight adults, but was not consistently related to overweight in adolescence (Ledoux et al., 2011). A large prospective cohort study conducted in the USA by Field et al. showed that fruit intake was not related to BMI z-score change in adolescents, and vegetable intake was inversely related to BMI z-score change in boys only (Field et al., 2003). Adjustment for energy intake accounted for the effect of vegetable on BMI z-score change in boys, suggesting that vegetable intake does not directly influence BMI z-scores. A large, cross-sectional study conducted across 34 countries (mainly European) demonstrated a lack of an association between frequency of fruit and vegetable consumption and overweight (Janssen et al., 2004), as did analysis of baseline data of FV intake from a large group of Fijian adolescents assessed before participation in a community-based intervention (Wate et al., 2013). The consumption patterns from these international studies may not be applicable to Australian adolescents due to cultural differences associated with diet, however, they represent the best available evidence. To date, the majority of this cross-sectional study evidence does not support an association between weight status and intake of fruit and vegetables.

Experimental studies on the effect of increased fruit and vegetable consumption in children and adolescents has been limited. A recent systematic review of interventions to increase fruit and vegetable intake in overweight children and adolescents found no experimental studies involving participants older than 12 years (Bourke et al., 2014), suggesting a significant gap in the literature. One experimental study by Epstein et al. (2001) showed that younger children (8-12 years) who increased their fruit and vegetable intake also had a significant decrease in their intake of high-fat/high-sugar foods. This approach has potential use as part of a dietary intervention but the effectiveness is likely influenced by the subject group. The previous study involved normal weight children who were at risk of
becoming overweight, so findings may not be generalizable to treatment of overweight children or adolescents. While evidence suggests fruit and vegetable consumption may be important for obesity prevention and treatment, without solid data to explain the role of fruit and vegetable intake in adolescent obesity treatment, the importance of fruit and vegetable intake as an intervention component of dietary treatment still remains unclear.

### 2.1.2.3 Eating behaviours related to weight gain

Behaviours like skipping breakfast (Deshmukh-Taskar et al., 2010), eating in front of the television (Feldman et al., 2007) and eating away from parents (Burgess-Champoux et al., 2009) have all been linked to increased risk of overweight and obesity and are discussed in detail below. If these behaviours contribute to overweight adolescent food consumption patterns, they could be targeted in obesity interventions.

#### 2.1.2.3.1 Skipping breakfast

Different methods of reporting or measuring breakfast consumption or breakfast skipping can make it difficult to compare results between trials (Pearson et al., 2009a). For example, data may come from a short questionnaire about the frequency of breakfast consumption (Berkey et al., 2003), a rating of how often the subject might skip breakfast (Hallström et al., 2011), a meal eaten between 0600-0900 hours (Corder et al., 2014) or if the meal was labelled as breakfast by the subject (Deshmukh-Taskar et al., 2010). However, consistent evidence supports the relationship between skipping breakfast and increased BMI (Deshmukh-Taskar et al., 2010, Dupuy et al., 2011, Sun et al., 2009, Wate et al., 2013). An example of this includes cross-sectional data collected using 24-hour recalls from the 1999-2006 NHANES surveys. Results were adjusted for energy intake and suggested that in adolescents, skipping breakfast was related to higher BMI z-scores and higher waist circumference measurements (Deshmukh-Taskar et al., 2010). Other large cross-sectional studies in French (Dupuy et al., 2011), Japanese (Sun et al., 2009) and Fijian (Wate et al., 2013) adolescents have also shown that regular breakfast consumption is associated with lower BMI. A large, school-based prospective study in the USA suggested that breakfast skipping increased with age for adolescents and
reduced breakfast consumption over this time predicted increased BMI z-scores at follow up (Niemeier et al., 2006). However, this study did not control for other dietary factors, such as energy intake or junk food consumption, which may confound the relationship. Thus, breakfast skipping may only be an indicator of overall poor diet. Conflicting evidence from a cross-sectional study of 474 obese Swedish adolescents showed that breakfast skipping was not related to body fatness in this cohort (Vagstrand et al., 2006). Skipping breakfast has also been related to a higher likelihood of making poor nutrition choices during the day (Vagstrand et al., 2006). A large cross-sectional study from the USA (n= 711) found that adolescents who skipped breakfast had a higher percentage of their energy intake coming from fat than those who consumed breakfast (Nicklas et al., 2000). In this study, the percentage of adolescents who did not meet the American guidelines for vitamin and mineral intake was significantly higher in those who skipped breakfast (Nicklas et al., 2000). Using the NHANES data, Deshmukh-Taskar et al. (2010) also showed that adolescents who skipped breakfast were also less likely to consume fruits and vegetables and had a greater percentage of energy contributed by added sugars than those who had breakfast. Skipping breakfast may also have a negative impact on concentration levels and capacity for learning and therefore school performance (Rampersaud et al., 2005). Hence, there appears to be reasonably consistent evidence to suggest that breakfast consumption is associated with improved diet and reduced levels of obesity, and may be an important target for interventions.

### 2.1.2.3.2 Eating meals away from the family

Adolescent involvement in family meals has been advocated as an important target behaviour to prevent weight gain, although the role in obesity treatment is less clear (Barlow, 2007). In the majority of studies family meals are described as a meal eaten with all or most of the family who live in the same house (Hammons and Fiese, 2011). Longitudinal evidence from a population-based study by Burgess-Champoux et al. (2009) suggests a reduction in regular family meals as American children progress through adolescence, coinciding with a general decline in the quality of adolescent diet. Cross-sectional analysis of a large American adolescent
cohort showed that family meal frequency was only associated with overweight status in younger adolescent girls, with no relationship observed for adolescent boys or older adolescent girls (Fulkerson et al., 2008). The authors tracked participants for a further five year period, however this data did not show any significant associations between progression of overweight and family meal frequency for any sub-group of the cohort (Fulkerson et al., 2008). Results from a study of more than 14,000 American adolescents who were the offspring from participants in the Nurses’ Health Study showed an inverse relationship between overweight and frequency of family dinners at baseline (Taveras et al., 2005b). However, there was no relationship found between the frequency of family dinners and incidence of becoming overweight in the next year (Taveras et al., 2005b). A strength of this study was the longitudinal analyses using a very large sample of adolescents from across America, although the high level of homogeneity in the sample (subjects were offspring of nurses and the majority were white) limit the generalizability of the findings. In similar analyses, Sen (2006) also used longitudinal and cross-sectional data from the 1997 USA National Longitudinal Survey of Youth data to show that for white adolescents only, frequent family meals were protective against becoming overweight, and associated with higher odds of ceasing to be overweight at three years follow up (Sen, 2006). These findings did not apply to black or Hispanic adolescents and despite the recent analysis, diet is likely to have changed since the data was collected in 1997. A meta-analysis of eight studies investigating family meals and weight status concluded that both children and adolescents were 12% less likely to be overweight if they shared at least three meals with their family per week, as opposed to those who didn’t share at least three family meals (Hammons and Fiese, 2011). Further research is needed to understand the role of increased family meal frequency in the treatment of obesity.

Despite the lack of a clear link between family meal frequency and weight, cross-sectional data supports a relationship between family meal frequency and healthful diets in adolescence, including greater consumption of fruit and vegetables and less fried foods (Gillman et al., 2000, Neumark-Sztainer et al., 2003). A longitudinal study of 677 adolescents from the USA compared frequency of family meals in early and
middle adolescence and showed that regular family meals (≥five family meals per week) were associated with reduced fast-food consumption in males and increased consumption of vegetables in middle adolescence. However, no association was found with energy intake as measured using a 149-item semiquantitative YAQ, which may help to explain the lack of relationship between family meal frequency and overweight (Burgess-Champoux et al., 2009). In a study of 3,223 young Canadian adolescents, self-reported frequency of family meals and SSB intake were found to be inversely associated (Woodruff and Hanning, 2009). A small cross-sectional study of adolescent girls and their parents in the USA found that regular shared dinner times were positively associated with intake of fruit and vegetables (Bauer et al., 2011). A meta-analysis of the effect of family mealtimes on diet found adolescents who shared family meals at least three times per week had 25% higher odds of eating healthy foods (fruits, vegetables and breakfast), compared to those who didn’t share frequent family meals. The odds of eating unhealthy foods were 26% lower in the adolescents frequently consuming family meals (Hammons and Fiese, 2011). Thus evidence supports a relationship between better diet and family meal frequency. Further research is needed to clarify how regular family meals improve diet and how this may be useful in obesity interventions.

An exploration of what the specific mechanism by which family meals influence diet quality suggests that watching television can affect the nutritional value of shared family meals (Braude and Stevenson, Feldman et al., 2007). An experimental study in young women concluded that TV disrupts the conscious act of eating and inhibits regulation of intake (Braude and Stevenson). A large cross-sectional study of adolescents in the USA found significant associations between watching TV during meals and higher consumption of chips and SSBs, and lower intake of vegetables (Feldman et al., 2007). However, family meals in front of the television remained more strongly positively associated with a more healthful diet as compared to the diet of adolescents who were not eating meals regularly with their family (Feldman et al., 2007).
2.1.2.4 Summary of dietary factors influencing weight gain

A number of dietary factors, such as consumption of some foods and certain eating behaviours, have been associated with a greater prevalence of overweight and obesity in adolescents. However, there is no clear evidence to suggest that adolescent obesity treatment should target any of these dietary factors over another. It remains unclear as to which dietary factors are the most efficacious to target in the treatment of obesity. Further, a comparison of diets between healthy weight and overweight adolescents does not account for other contributors to energy balance, such as physical activity and sedentary behaviour. Thus, based on the best available evidence, dietary interventions will continue to target behaviours that are only possibly important in the management of obesity. Regardless, a detailed comparison of healthy weight and overweight/obese adolescent diets can help to further understand the strength of the relationships between different aspects of diet and adolescent obesity. A better understanding of any differences in diet will provide stronger evidence to guide future interventions.

2.1.3 Diet of the general adolescent population compared to the overweight adolescent population

Evidence from the most recent national Australian dietary survey of youth suggests that adolescents are generally not consuming healthful diets, with low intakes of fruit and vegetables and high intakes of fat and sugar (Australian Bureau of Statistics, 2012c). Despite the importance of good nutrition for adequate growth and development during this life stage (National Health and Medical Research Council, 2013a), it appears that adolescents of all weight statuses are making poor dietary choices that may put them at risk of increasing weight gain. Given the link between poor diet and increased risk of obesity, it is reasonable to hypothesise that overweight and obese adolescents may consume diets that contribute to a greater energy intake than that of their healthy weight peers. They may also engage in more unhealthy eating behaviours. However, the bulk of evidence suggests otherwise, with cross-sectional studies from Vance et al. (2009), Yannakoulia et al. (2012) and Garaulet et al. (2000) all showing that overweight adolescents do not report greater energy intakes than healthy weight adolescents. This finding,
however, may be influenced by factors such as differential underreporting. Therefore, more comprehensive descriptions of intake, such as food group intake and frequency of engaging in related eating behaviours, are useful to understand any differences in diet between healthy weight and overweight adolescents.

An understanding of the detailed diet differences between healthy weight and overweight adolescents may be important to guide the development of dietary intervention targets for overweight adolescents. For example, an awareness of the difference in intake of food groups and eating behaviours, rather than just energy or nutrient intake, will allow for the development of more tailored food-based interventions suited to overweight adolescents. The following section explores the reported differences between the general adolescent population and overweight adolescents across the areas of energy intake, food group intake, nutrient intake and eating behaviours. The first part of each section begins with a description of the relevant dietary guidelines (National Health and Medical Research Council, 2013a) or clinical practice guidelines in Australia (National Health and Medical Research Council, 2013b). This is followed by a review of the general adolescent diet, with most of the evidence coming from large, nationally-representative surveys. The second part of each section details the data for overweight adolescents and includes some observational evidence from intervention studies. In overweight adolescents, intervention studies are mainly lifestyle interventions and the development and effectiveness of these is reviewed in section 2.3. Dietary data is often not extensively reported in lifestyle interventions, with most studies only reporting a small number of dietary findings. When reported, baseline nutrition data from these studies can be useful to understand more about what overweight and obese adolescents eat. The following data from interventions studies with overweight adolescents is taken from the self-reported intakes of the intervention groups at baseline in each trial. The third part of each section compares the existing data for healthy weight adolescents and overweight adolescents, based on studies that provide separate data based on weight status. A summary of the key findings in this area can also be seen in Table 2.1. Given the general lack of detailed descriptions of adolescent dietary intake, the following review includes a number of
international studies that consider adolescent groups from different cultural backgrounds. Although this data may not be directly applicable to Australian adolescents, it is the best evidence available and the research methodology of the individual studies is generally strong.
Table 2.1 Comparison of general and overweight/obese adolescent diet across energy, food groups, nutrients and eating behaviours

<table>
<thead>
<tr>
<th>Aspect of diet</th>
<th>Clinical practice guidelines</th>
<th>General adolescent diet*</th>
<th>Overweight/obese adolescent</th>
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<tr>
<td><strong>Energy</strong></td>
<td>9200-11800 kJ (combined boys and girls)(National Health and Medical Research Council, 2006)</td>
<td>14-16 years: 9158kJ (Australian Bureau of Statistics (ABS), 2012c) a</td>
<td>OW adolescents 14-16 years: 8451 kJ</td>
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<td>OB adolescents 14-16 years: 7807 kJ (Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008) a</td>
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<td><strong>Food groups</strong></td>
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<tr>
<td>-Fast food</td>
<td>Prepare more meals at home rather than purchasing restaurant food (Barlow, 2007)</td>
<td>22.1% consume daily (Savige et al., 2007)b</td>
<td>42.2% ≥1/week (Morley et al., 2008) d</td>
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<td></td>
<td></td>
<td>43.6% healthy weight ≥1/week (Morley et al., 2008) d</td>
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<td>-Sugar-sweetened beverages</td>
<td>Minimize sugar-sweetened beverages, such as soda and sports drinks (Barlow, 2007)</td>
<td>39.4% consume daily (Savige et al., 2007)b</td>
<td>31.4% ≥4 cups/week (Morley et al., 2008) d</td>
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<td></td>
<td></td>
<td>30.1% healthy weight ≥4 cups/week (Morley et al., 2008) d</td>
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<td>-Other junk</td>
<td>Limit intake (National Health and Medical Research Council, 2013c)</td>
<td>49.3% consume daily (Savige et al., 2007)b</td>
<td>3.3 servings of ‘fat’ (Shaibi et al., 2012) d</td>
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<tr>
<td>-Fruit and vegetables</td>
<td>≥2 servings of fruit (National Health and Medical Research Council, 2013c)</td>
<td>41.2% healthy weight consumed ≥2 servings fruit (Morley et al., 2008) d</td>
<td>42.6% consumed ≥3 servings fruit (Morley et al., 2008) d</td>
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*a Australian comparison (international comparison in text)*

*b Morley et al., 2008*

c Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008

d National Health and Medical Research Council, 2013c
<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Macronutrients</th>
<th>Fat: &lt;35% of total energy (National Health and Medical Research Council, 2006)</th>
<th>Fat: 32.6% of total energy (ABS, 2012c)</th>
<th>Fat: 28% (Nemet et al., 2006)(^c), 33.3% (Davis et al., 2011)(^c), 34.9% (Bean et al., 2011)(^a), of total energy</th>
<th>Fibre:20-22g girls, 24-28g boys (National Health and Medical Research Council, 2006)</th>
<th>Fibre: 20.8g (ABS, 2012c)</th>
<th>Fibre:13g (Bean et al., 2011)(^a) - 14.8g (Davis et al., 2011)(^c)</th>
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<td>≥5 servings of vegetables (National Health and Medical Research Council, 2013c)</td>
<td>≥5 servings of vegetables (National Health and Medical Research Council, 2006)</td>
<td>≥5 servings of vegetables (Morley et al., 2008)(^d)</td>
<td>23.7% healthy weight consumed ≥4 servings vegetables (Morley et al., 2008)(^d)</td>
<td>23.9% consumed ≥4 servings vegetables (Morley et al., 2008)(^d)</td>
<td>71% consumed ≥2 servings fruit (Shrewsbury et al., 2011a)(^b)</td>
<td>26% consumed ≥4 servings vegetables (Shrewsbury et al., 2011a)(^b)</td>
<td>2.9 combined servings/day (Shaibi et al., 2012(^d), Wengle et al., 2011(^b&amp;(^c))</td>
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<td>Micronutrients</td>
<td>Calcium: 1050mg (National Health and Medical Research Council, 2006)</td>
<td>Calcium: 833.4mg (ABS, 2012)</td>
<td>Calcium: 432mg (Nemet et al., 2006) to 727mg (Bean et al., 2011)</td>
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<td>Eating behaviours</td>
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<tr>
<td>Breakfast</td>
<td>Eat breakfast regularly (National Health and Medical Research Council, 2013)</td>
<td>36.9% eat daily (Brener et al., 2013)</td>
<td>52% eat daily (Shrewsbury et al., 2011a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Average consumption on 4.86 days/week (DeBar et al., 2012)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family meals</td>
<td>Whenever possible, eat meals as a family (National Health and Medical Research Council, 2013b)</td>
<td>Dinner: 76.8% have every day (Brener et al., 2013)</td>
<td>Dinner: 82% have every day (Shrewsbury et al., 2011a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Separate eating from other activities such as watching television (National Health and Medical Research Council, 2013b)</td>
<td>Family meal every day: 36.9% (Brener et al., 2013)</td>
<td>Average of 3.85 family meals/week (Shrewsbury et al., 2011a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TV on during dinner: 41.0% (Brener et al., 2013)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

OW: Overweight, OB: Obese

*a includes underweight, healthy weight and overweight children aged 14-16 in Australia

*a 24-hour recall, b Food frequency questionnaire, c Food record, d Short eating behaviour questionnaire
2.1.3.1 Energy intake

The Nutrient Reference Values for Australia and New Zealand released by the National Health and Medical Research Council (NHMRC) provide estimated energy requirements (EERs) for adolescents aged 12-16 years engaging in light daily activity that range from 8500-9500 kJ (2033 kCal-2272 kCal) for girls to 9300-11800 kJ (2225 kCal-2823 kCal) for boys (National Health and Medical Research Council, 2006). When assessing energy intake in reference to these requirements, caution should be exercised in the interpretation of reported energy intake as underreporting can occur (Forrestal, 2011), as discussed in detail in section 2.1.4.

Dietary intakes from the Australian Health Survey 2011-12 were measured using 24-hour diet recalls (Australian Bureau of Statistics, 2012c). The results suggest that for the general adolescent population, including healthy weight and overweight adolescents, mean energy intake was 8,114 kJ for girls aged 14-18 years and 10,186 kJ for boys of the same age. The mean energy intake for combined boys and girls aged 14-18 year olds was 9,159 kJ. Dietary intakes of adolescents aged 12-16 years in Western Australia were measured using 24-hour dietary records and FFQ (Martin et al., 2008). These findings showed an energy intake around 9,359 kJ for secondary school students (Martin et al., 2008). These data from these studies reflect energy intakes that are slightly less than, or equivalent to the estimated energy requirements in the general adolescent population.

In overweight adolescents entering an intervention, data from 24-hour food recalls suggest energy intake ranges from 6,692 kJ (1,601 kCal) in American adolescent girls (DeBar et al., 2012), to 8,736 kJ (2,090 kCal) in ethnically diverse adolescents also from the USA (Bean et al., 2011). Food record data showed similar ranges between 7473 kJ (1788 kCal) in Latino adolescents (Davis et al., 2011) and 9133 kJ (2185 kCal) in Israeli adolescents (Nemet et al., 2006). The use of a 131-item FFQ used to collect data pre-intervention, suggested a higher energy intake for American adolescents living in rural areas (9659 kJ, 2311 kCal) (Janicke et al., 2008a). Of the studies described, only Bean et al. (2011) attempted to assess the extent of underreporting, although the authors did not make appropriate statistical adjustments to account for underreporting (see further details on methods of
dealing with underreporting in section 2.1.4.4). Thus the energy intakes reported by DeBar et al. (2012), Bean et al. (2011), Davis et al. (2009a), Nemet et al. (2006) and Janicke et al. (2008a) may be biased by underreporting which is thought to be common in overweight adolescents (Forrestal, 2011).

The following studies include analysis of energy intake by weight status. In a cross-sectional study of 1917 Canadian adolescents aged 13-15 years, energy intake was measured using a 24-hour dietary recall. Results showed that females reported a similar energy intake across the three overweight, obese and healthy weight groups (Vance et al., 2009). However, obese males reported a lower energy intake than their overweight or healthy weight peers (Vance et al., 2009). In this study underreporting was assessed using a ratio of reported energy intake to estimated basal metabolic rate, with results suggesting that the extent of underreporting increased with increasing weight status for males and females. Despite this finding, no further action was taking to quantify the impact of underreporting on the findings. There is no consensus on how to best deal with underreporting, which is discussed in detail in section 2.1.4.4. However, the lack of an association between energy intake and weight status may reflect the presence of underreporting. Vance et al. (2009) also only reported energy intake, but did not describe intake from the different food groups or macronutrient contribution to total energy intake. Further detail would have been useful to identify foods that may have been selectively underreported and to explain the energy intake findings. Similar results were reported in a study of Mediterranean adolescents (n=120) by Yannakoulia et al. (2012) using three day food records. No difference in energy intake between healthy weight and overweight adolescents was observed. Another cross-sectional study of Mediterranean adolescents (n=331) used a seven day food record to measure dietary intake (Garaulet et al., 2000). This study showed that overweight males and females reported less total energy consumption, as compared to healthy weight adolescents. Underreporting was shown to increase with increasing weight status, thus, the energy intake of overweight and obese subjects may have been underestimated. By contrast, in a larger cross sectional study of 1157 Iranian adolescents, 24-hour recall data suggested that overweight adolescents actually
consumed more energy than their healthy weight counterparts (Hatami et al., 2014). It is difficult to directly compare study outcomes given the use of different dietary assessment methods and inconsistent adjustments for underreporting. Additionally, cross-sectional studies cannot be used to show cause and effect, and lower intakes may accurately reflect attempted energy restriction for weight loss. The lower energy intakes in the overweight group could also be a true assessment, indicating the impact of other energy balance factors on weight status. At this stage, there appears to be a lack of consistent evidence to suggest a difference in energy intake between healthy weight and overweight adolescents.

2.1.3.2 Food group intake
There appears to be few studies reporting detailed food group intake that covers all aspects of fruit, vegetable intake and junk food consumption. Food group-based data may be lacking given Australian Guidelines have only been recently revised to highlight the importance of a change in focus from nutrient to food group-based guidelines (Department of Health and Ageing and National Health and Medical Research Council, 2011). Thus, there is only a small amount of evidence regarding food group intake to guide adolescent dietary interventions. The existing Australian literature suggests that overall adolescent diet is characterised by low intakes of fruits and vegetables and high intakes of junk foods (Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008, Martin et al., 2008). The relevant studies are reviewed in detail in the following section, however the findings cannot be directly compared because of differences in the dietary assessment methods used to estimate food group intake.

2.1.3.2.1 Fruit and vegetable intake
For both fruits and vegetables, the percentage of children meeting the dietary guidelines declines from primary school to secondary school (Martin et al., 2008), potentially suggesting that the quality of food group intake declines in the transition from childhood into adolescence. In the 2012 Australian Health Survey, only 23.2% of adolescent girls and 20.0% of adolescent boys aged 12-15 years from all weight statuses met the Australian Government’s daily food selection guideline for fruit consumption (3 serves per day) on the day of the study (Australian Bureau of
Statistics, 2012b). The data also showed that only 15.5% of girls and 11.8% of boys met the guideline for vegetable intake (4 serves per day) (Australian Bureau of Statistics, 2012b). This data was reported by parents on behalf of the adolescent in most cases, and was derived from two standardised items on a larger questionnaire. There is potential that this is not a valid representation of intake. In the most recent national Australian survey of daily intake using a 24-hour diet recall, less than 1% of 14-16 year olds consumed ≥3 servings of fruit and 5% consumed ≥4 servings of vegetables (Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008). The mean daily intake was only 0.9 servings of fruit and 2.7 servings of vegetables for adolescents aged 14-16 years. The data from this study, which is the best available representation of Australia adolescent intake, was not stratified by weight status, so the following comparisons come from other cross-sectional studies and smaller intervention studies.

In overweight adolescent intervention studies, the reporting of intake from different food groups has not been standardised and many studies report fruit and vegetable intake in a different way. For example, different countries do not use the same dietary assessment methods to assess intake or common serving sizes are different. In the USA, fruit and vegetable intake is often combined and reported as one food group, however, in Australia and Europe the two food groups are usually presented separately. In the USA, one serve of vegetables is one cup of vegetables or two cups of leafy greens (United States Department of Agriculture, 2014), whilst in Australia one serving of vegetables is half a cup of cooked vegetables or one cup of salad vegetables (National Health and Medical Research Council, 2013c). This makes comparisons between international studies particularly difficult. Shrewsbury et al. (2011a) used an FFQ to show that 26% of overweight Australian adolescents consumed ≥4 serves of vegetables every day, whilst 71% of overweight adolescents reported consuming ≥2 servings of fruit every day prior to intervention. Lubans et al. (2011) assessed four dietary behaviours using a short questionnaire in a group of Australian adolescent boys (35% were overweight or obese). Results showed that 12% of the boys in their trial consumed ≥4 serves of vegetables every day and 52% consumed ≥2 servings of fruit. In terms of the amount of fruit and vegetables
consumed by overweight adolescents, Shaibi et al. (2012) used a brief screening tool to show that American adolescents reported daily consumption of 2.9 combined servings of fruits and vegetables. However, the use of FFQs or short questionnaires may overestimate fruit and vegetable consumption (Calvert et al., 1997, Di Noia and Contento, 2009). This limitation is discussed further in section 2.1.4.2.2. Using four day food records, Wengle et al. (2011) measured dietary intake of 38 overweight adolescents and estimated an intake of 2.4 combined servings of fruit and vegetables per day. Pre-intervention assessment of diet using 24-hour recalls with 67 obese adolescents in another study also showed reported 2.4 daily servings of fruit and vegetables (Bean et al., 2011). Further distinction between fruit and vegetable servings was not provided in these American studies. Interpretations of the data from intervention trials are limited by different measures but the evidence suggests generally low intakes of fruits and vegetables by overweight and obese adolescents.

A small number of large cross-sectional studies have been used to compare fruit and vegetable intake by weight status. Internationally in a cross-sectional study of Saudi Arabian adolescents, Al-Hazzaa et al. (2012) found that overweight adolescents reported a lower intake of fruit but no difference in vegetable intake when compared to healthy weight adolescents. Conversely, cross-sectional comparisons of fruit and vegetable intake in a small study of Mediterranean adolescents showed that overweight adolescents reported higher intakes of vegetables than healthy weight adolescents, despite reporting similar energy intakes (Yannakoulia et al., 2012). In this analysis, participants classified as extremely low energy reporters were excluded, potentially skewing the results of the group as overweight subjects were more likely to report low energy intakes (Rennie et al., 2007). Further, overweight subjects have been shown to report less non-core foods, such as cake and ice cream, than healthy weight adolescents (Lioret et al., 2011), and this is discussed further in section 2.1.4.5.1. Cross-sectional data from 1803 adolescents in NHANES III (1988-1994) was used to show a relationship between central adiposity and fruit and vegetable intake. Adolescents who had a waist circumference greater than the 85th percentile for age and sex were defined
as having central obesity. Adolescents with central obesity reported consuming less fruit and vegetables than those who did not have central obesity (Bradlee et al., 2010). In Australia, the recent National Secondary Students’ Diet and Activity survey showed that there was no difference in fruit or vegetable consumption when broken down by BMI (Morley et al., 2008). The proportion of overweight adolescents meeting the dietary recommendations for fruit was 42.6% compared to 41.2% of healthy weight adolescents. For vegetables, 23.9% of overweight adolescents met the dietary recommendations compared to 23.7% of healthy weight adolescents. As with overall energy intake, there is a lack of consistent evidence to support a clear relationship between overweight status and fruit or vegetable intake. The weight of the evidence does seem to suggest that overweight adolescent intake of fruits and vegetables are largely similar to that of the general adolescent population.

2.1.3.2.2 Junk food intake

Adolescent intake of junk food is generally higher than recommended (Rangan et al., 2008), although a lack of consistent reporting makes it difficult to compare between studies. For example, junk food is not consistently analysed as a whole food group constituting all energy-dense, nutrient-poor foods and beverages, nor are there detailed reports of all components of junk food. One study may assess frequency of fast food consumption only, whilst another measures intake of high energy foods such as pizza and chocolate. The most common way of reporting junk food intake is in terms of sub categories of junk foods, such as only fast food or SSBs and less frequently as energy-dense snacks.

National Australian data suggests that as they age, adolescents eat more food obtained out of the home, and these foods generally have a high relative fat content (Rangan et al., 2008). A state-wide survey in Western Australia showed that 13.7% girls and 26.4% boys consumed meals or snacks from a fast food restaurant once a week and a further 7.1% of boys had fast food two to four times per week (Martin et al., 2008). A large cross sectional Australian study showed higher levels of fast food consumption with 22.1% of adolescents consuming fast food daily (Savige et al., 2007). This study also showed that 39.4% of adolescents consumed SSBs daily.
An Australian study reported 40% of adolescents had consumed SSBs on the day of the study, with a mean intake between 199-567g (Commonwealth Scientific and Industrial Research Organisation, 2012). The most recent National Health Survey showed an average of 309g of SSB consumption on the day of the survey in 14-18 year olds. There is little current evidence for consumption rates of other energy-dense foods, often because these foods aren’t measured in a consistent way. In terms of energy-dense snack foods, the 1995 Australian National Nutrition Survey reported that 49.3% of adolescents consumed these daily (Savige et al., 2007). This evidence suggests generally high intakes of junk foods for the general adolescent population.

Overweight adolescent intake of junk foods is also difficult to compare between studies due to a lack of standardised measures and definitions. In terms of fast food consumption by Canadian and American adolescents, Wengle et al. (2011) reported overweight adolescents consumed fast food 1.1 times per week, whilst DeBar et al. (2012) reported 1.2 times per week. Shrewsbury et al. (2011a) described only 33% of their obese Australian adolescent sample ‘never or rarely’ having fast food and 46% ‘never or rarely’ having SSB. In a mixed weight status group of Australian adolescents, Lubans et al. (2011) found that 52% of boys were having less than one SSB per day. Shaibi et al. (2012) measured dietary intake in a group of 15 Latino adolescents using a brief screening tool, which defined servings of ‘fat’ as foods that contribute to the top 60% of fat intake such as fried chicken, whole milk, French fries and cake (Wakimoto et al., 2006). This study reported 3.3 servings of ‘fat’ per day in this group of adolescents and although the sample size was very small, the approach for measuring junk food was interesting. Wengle et al. (2011) reported 4.2 servings of high fat/sugar foods per week but the study lacked a clear definition for how these servings were calculated, or why they were assessed over a week.

These baseline intervention study data are all limited by self-report and are likely to underestimate the true extent of discretionary food intake.

There is limited data available comparing healthy weight and overweight adolescent junk food intake. The 2010 National Youth Physical Activity and Nutrition Study in the USA showed that overweight adolescents did not consume more sweetened
beverages than healthy weight adolescents (Centers for Disease Control and Prevention, 2011). A smaller cross-sectional study of Mediterranean adolescents showed higher consumption levels of fast food in the overweight group when compared to the healthy weight group (Yannakoulia et al., 2012). Data from the recent Australian National Secondary Students’ Diet and Activity survey showed that self-reported SSB and fast food consumption did not differ between healthy weight and overweight adolescents (Morley et al., 2008). There was no data found comparing other energy-dense snacks by weight status.

There is insufficient evidence to suggest a large difference in fruit and vegetable intake or junk food intake between general adolescents and overweight adolescents. The lack of dietary data from large samples of overweight adolescents contributes to this paucity of evidence, as does a well-defined method of food group measurement. However, there is sufficient evidence to show that fruit and vegetable intake remains substantially lower than recommendations, thus it may be an important target for intervention.

### 2.1.3.3 Nutrient intake

A clear link between nutrient composition and overweight has not been shown. Although a food group-based approach may be most relevant to adolescents, it may be important to consider any differences in nutrient intakes, including both macro and micronutrients, to guide diet recommendations for overweight adolescent (National Health and Medical Research Council, 2013b). This is particularly important in the context of adolescent development needs and to describe the quality of the diet. For example, the percentage of energy provided by fat may provide insight into junk food consumption and fibre may be useful to support findings regarding fruit and vegetable intake. Of the micronutrients, there are often detailed intake estimates available for the general population but intake for the overweight adolescent population is often limited to key reflectors of nutritional adequacy like calcium and iron. A summary and comparison of adolescent intake of these key nutrients are presented below. It should be noted that this is not a comprehensive review of all nutrients, as there is insufficient evidence to compare
intake of macro-nutrients such as carbohydrate and protein between adolescent
groups of differing weight status.

The Acceptable Macronutrient Distribution Range defines a healthy diet as one with
20-35% of energy coming from fat and less than 10% of energy coming from
saturated fat (National Health and Medical Research Council, 2006). Australian data
from 2012 showed that for adolescents, the contribution of fat to total energy
intake was within healthy guidelines at 32.6% (Australian Bureau of Statistics,
2012c). However, the median consumption of saturated fat for adolescents aged
14-18 years was 12.8%, which is above the recommended guideline of <10%
(Australian Bureau of Statistics, 2012c). In adolescent intervention studies, Nemet
et al. (2006) found that in small group of overweight Israeli adolescents (n=24), 28%
of total energy came from fat. In a group of 67 overweight American adolescents,
Bean et al. (2011) reported 34.9% of total energy coming from fat and 11.4% of
energy coming from saturated fat while in a group of 54 Latino adolescents, Davis et
al. (2011) reported 32.8% of energy coming from fat. The latter studies included
sample sizes that were larger than the Nemet et al. (2006) study, but still had less
than 70 participants. Such small sample sizes are unlikely to be representative of
the greater population of overweight adolescents and may be influenced by
extreme outliers. In an analysis of healthy weight and overweight adolescents,
Garaulet et al. (2000) showed that the percentage of total energy derived from fat
was significantly higher in overweight adolescent males than healthy weight males.
The total energy derived from fat was not different between healthy and
overweight females, but within the overweight females, the percentage of energy
derived from fat increased with greater BMI (Garaulet et al., 2000). This study was
limited by the use of a single BMI cut-off to identify overweight adolescents
(BMI≥23), classifying more adolescents as overweight than the accepted Australian
definition of overweight (BMI for age and sex > 85th percentile), making it difficult to
compare findings. Adolescents were also asked to report their dietary intake for a
relatively long reporting period of seven days, potentially increasing the chance of
underreporting over time (Livingstone and Robson, 2000, Thompson and Subar,
2013), although the impact of underreporting was not considered. Overall, the
contribution of fat to total energy does not appear to differ by weight status in adolescents, although the accuracy of overweight adolescent data is likely to be reduced by underreporting and the impact of small sample sizes.

There is very little evidence for the usual intake of fibre by adolescents. Background data used in the development of Australian healthy eating guidelines shows that 40% of fibre intake comes from fruits and vegetables (National Health and Medical Research Council, 2006). Given the relatively low adolescent intakes of these foods as described above, it would be expected that fibre intakes were also low for a large proportion of adolescents. Recommendations for Adequate Intakes of fibre increase with age for Australian adolescents and range from 20 to 22g for girls and from 24 to 28g per day for boys (National Health and Medical Research Council, 2006). In the most recent national survey, Australian adolescent intake of fibre was reported to be 20.8g per day (Australian Bureau of Statistics, 2012c). For overweight adolescents, previously reported intakes suggest a mean intake of 13g in a group of 12-15 year olds (Bean et al., 2011) and 14.8g in a group of 14-16 year olds (Davis et al., 2011). These intakes seem much lower than for other adolescents, despite similar methods of measurement, particularly in the former study. Although no Australian data exists to directly compare healthy weight and overweight adolescents’ intakes of fibre, a large cohort study of Greek children and adolescents showed that obese girls consumed more fibre per 4,200 kJ than healthy weight girls (Manios et al., 2013). From the small amount of data available, there does not seem to be a consistent trend for fibre intake differences between healthy weight and overweight adolescents.

Estimation of absolute nutrient intake often needs a long period of data collection and dietary assessment methods that suit adolescents are not designed to capture day-to-day variation over a long time periods (Livingstone and Robson, 2000). The following nutrient intakes are likely to be biased by imprecise dietary assessment methods, but can still be used to give an idea of overweight adolescent intake. This will be useful to determine if overweight adolescents have a lower intake than general adolescents of key nutrients for growth and development. In particular, calcium and iron are important micronutrients during adolescence and can be used
as indicators of nutritional adequacy. However, their direct relationship with obesity is not well understood. It is possible that overweight adolescents consume more non-core foods which might displace consumption of core foods that are nutrient dense. This has been shown for calcium, with SSBs thought to displace calcium-rich drinks such as milk (Vartanian et al., 2007, Harnack et al., 1999).

The estimated average requirement for calcium for Australian adolescents is 1050mg daily (National Health and Medical Research Council, 2006), with national data suggesting an average intake around 833.4mg (Australian Bureau of Statistics, 2012c). In two small intervention studies for overweight adolescents, calcium was the mineral most often reported at levels lower than recommended at 727mg (Bean et al., 2011) and 432mg (Nemet et al., 2006). Data provided by 24-hour recall in Manios et al. (2013) study of Greek children and adolescents did not detect a difference in calcium intake between overweight and healthy weight subjects. There is a lack of well-powered studies in cohorts with similar backgrounds to compare any potential differences in calcium intake between healthy weight and overweight adolescents.

The estimated average requirement for iron is between 6-8mg per day (National Health and Medical Research Council, 2006), with national Australian data showing a reported intake of almost 11mg per day (Australian Bureau of Statistics, 2012c). Only one small obesity intervention study (n=24) reported adolescent iron intake at baseline, and this exceeded requirements at 10.1mg (Nemet et al., 2006). However, in studies comparing healthy weight and overweight children and adolescents, data from an Israeli study (Pinhas-Hamiel et al., 2003) (n=321) and a large Greek cohort (Manios et al., 2013) (n=2492) show that iron deficiency may be more prevalent in overweight adolescents. Given these data come from adolescents of varying cultural backgrounds; the findings may not be directly applicable to Australian adolescents.

The weight of the evidence seems to suggest that overweight adolescent intake of most nutrients is not dissimilar to that of healthy weight adolescents. Calcium is the
one nutrient that appears to be significantly lower than the estimated average requirements; however this is also true for the general adolescent population.

2.1.3.4 Eating behaviours
Eating behaviours, such as eating a regular breakfast and sitting down to family meals, also change during adolescence and are influenced by a number of factors including food advertising, convenience of fast food outlets and peer pressure (Story et al., 2002). Recommendations around eating behaviours are not currently included in the Australian dietary guidelines or food selection guides. However, clinical practice guidelines for the management of overweight and obesity in adolescence do advocate for education around changing eating behaviours including breakfast consumption and shared family mealtimes (National Health and Medical Research Council, 2013b, Barlow, 2007).

2.1.3.4.1 Breakfast consumption
Daily breakfast consumption is encouraged in the dietary management of adolescent obesity as it contributes to a healthy pattern of eating (Barlow, 2007, National Health and Medical Research Council, 2013b). In the Western Australian adolescent population, 28.5% boys and 38.5% girls at secondary school reported skipping breakfast on the day of the study (Martin et al., 2008). In a Swedish cross-sectional study, 9.2% of girls and 3.0% of boys reported having no breakfast on a typical day (Vagstrand et al., 2006). There are fewer reports in the literature of overweight adolescents’ eating behaviours and most are based on single item dietary assessment methods or a small number of questions adapted from larger survey tools. Based on overweight adolescent self-report, Shrewsbury et al. (2011a) found that 52% of their sample ate something for breakfast every day, whilst DeBar et al. (2012) suggested an average consumption of breakfast on 4.9 days of the week. In comparisons by weight status, cross-sectional data from a large Polish study showed that overweight adolescents were more likely to skip breakfast than their healthy weight counterparts (Jodkowska et al., 2011). Although there are only a small number of studies directly comparing the breakfast habits of healthy weight
and overweight adolescents, the majority of the evidence seems to support the promotion of regular breakfast consumption in the treatment of adolescent obesity.

2.1.3.4.2 Family meals

As family meals are associated with reduced prevalence of obesity, better diet and other psychosocial benefits in adolescents, regular family meals are encouraged in the management of adolescent obesity (National Health and Medical Research Council, 2013b, Barlow, 2007). The following findings relate to regular consumption of dinner, family meals and the prevalence of television watching during dinner.

Using data from more than 11,000 American adolescents, Brener et al. (2013) showed that 76.8% of the general adolescent population reported consuming dinner every day. In terms of the meal environment, Western Australian data showed that 67.5% of adolescents consumed dinner with their family on five to seven nights per week. Similar results from a sample of 4,746 American adolescents showed that 66.9% of adolescents reported eating regular family meals (Feldman et al., 2007). For Western Australian adolescents, 18.4% reported watching television during the evening meal on 5-7 days per week (Martin et al., 2008) and about a third of the American adolescents reported watching television during family meals (Feldman et al., 2007).

Daily dinner consumption in overweight Australian adolescents was reported by 82% of the sample as measured by Shrewsbury et al. (2011a) and 57% reported eating dinner with their family every day. DeBar et al. (2012) reported an average of 3.85 family meals per week for overweight adolescents prior to intervention. Shrewsbury et al. (2011a) also showed that 53% of overweight adolescents reported eating dinner while watching television on at least six days of the week.

Cross-sectional comparisons of healthy weight and overweight Polish adolescents showed that overweight adolescents were more likely to miss dinner (Jodkowska et al., 2011). In Canadian adolescents, there was no difference between healthy weight or overweight adolescents regarding the likelihood of eating dinner with an adult family member (Lillico et al., 2014). However, the results from this study by Lillico et al. showed that obese Canadian adolescents were more likely to eat dinner
in front of the television than healthy weight adolescents (Lillico et al., 2014).
Overall, there do appear to be some differences in dinner habits and family meal
frequency between healthy weight and overweight adolescents.

2.1.3.5 Summary of the evidence for general adolescent diet
versus overweight adolescent diet
The overall diet of the general adolescent population appears to be generally poor
across food groups, nutrient intakes and eating behaviours; as does the diet of
overweight adolescents. Energy intake seems to be lower than estimated
requirements in overweight adolescents, although the majority of studies in this
area do not account for misreporting and may not represent accurate intakes in this
population. Although the evidence-base is not comprehensive, there are a number
of cross-sectional and intervention studies reporting baseline data regarding some
aspects of dietary intake for overweight adolescents. However, there remains
insufficient data within each study to understand patterns of intake in overweight
adolescents, or how this differs to the intake of adolescents as a whole. Without a
clear understanding of the overweight adolescent diet, it will remain difficult to
develop appropriate and relevant dietary interventions. Further detailed dietary
evidence needs to be collected in future interventions for overweight adolescents.

Identified gap: There is a significant lack of detailed evidence to describe
what overweight adolescents eat and drink.

2.1.4 Dietary assessment
Accurately estimating dietary intake can be particularly difficult (Beaton, 1994). In
metabolic studies, diet can be accurately measured through direct observation
under controlled conditions (Rutishauser, 2005). However, this does not provide an
estimate of usual dietary intake (Rich et al., 2013, Rutishauser, 2005), likely due to
the different food choices that may be available in a free living environment and the
influence of being observed (Rutishauser, 2005). Diet measured in a free living
situation can provide more information about habitual intakes, but is considerably
more error prone (Margetts and Nelson, 1997). Regardless, it is reported that
through adoption of the best-available assessment methods for the target group
being studied, useful information can still be collected about diet quality and eating behaviours (Rutishauser, 2005, Margetts and Nelson, 1997, Collins et al., 2010). Further, attempts to quantify bias in the dietary data, by identifying underreporting and assessing the impact on outcomes, can add confidence to the findings (Beaton, 1994).

2.1.4.1 Dietary assessment in overweight and obesity
In the selection of dietary assessment methods there are a number of additional factors to consider for overweight and obese adolescents. For overweight and obese patients/participants, clinical guidelines advocate for dietary assessment to include the measurement of modifiable eating habits that have been linked to energy balance (Barlow, 2007, National Health and Medical Research Council, 2013b). This includes aspects of diet such as frequency of fast food consumption, consumption of SSBs, consumption of energy-dense, nutrient-poor foods, consumption of fruit and vegetables, frequency and quality of breakfast, portion size estimation, amount of fruit juice consumed, and number of meals and snacks consumed per day (Barlow, 2007, National Health and Medical Research Council, 2013b). This level of information requires detailed data collection and is rarely reported from intervention studies in adolescents (Collins et al., 2006). The following section describes the dietary assessment methods available for use and highlights limitations associated with each tool in collecting this detailed level of information.

2.1.4.2 Dietary assessment methods used with adolescents
The collection of dietary data from free-living adolescents includes methods such as 24-hour dietary recalls, food frequency questionnaires, diet records and brief dietary screening tools. The selection of dietary assessment methods needs to be age appropriate and acceptable to adolescents (Livingstone and Robson, 2000). No method of self-reported intake provides completely accurate dietary intake data (Forrestal, 2011) and each method has associated advantages and limitations which are summarised in Table 2.2.
2.1.4.2.1 24-hour dietary recall

A 24-hour dietary recall requires the subject to provide a description of the previous day’s intake with details of the type and amount of food and beverages consumed (Rutishauser, 2005). A trained interviewer is usually needed, although a self-administered electronic program, known as the ASA-24 in the USA, is now available (Thompson and Subar, 2013, Moshfegh et al., 2008). The subject usually recalls all foods eaten during the previous 24 hours and then is prompted by the interviewer using a multiple pass technique (Rutishauser, 2005). The exact prompting technique may differ slightly between trials but usually includes one stage of uninterrupted recall of intakes, a second stage of probing questions about portion size and ingredient details, then a third stage of reviewing items and identifying missing items. This allows for multiple opportunities to recall foods that may have been forgotten during the initial recall. It may be useful to use 24-hour dietary recalls to measure diet when detail is needed regarding food groups and meal patterns (Thompson and Subar, 2013). The benefits of a 24-hour dietary recall, as detailed in Table 2.2, include a high respondent rate, detailed information on food intake in a 24 hour period and a relatively low level of participant burden (Thompson and Subar, 2013). The disadvantages of a 24-hour dietary recall include only one day of data that does not account for daily variation in the subject’s diet (Thompson and Subar, 2013, Rutishauser, 2005), an inability to assess frequency of key eating behaviours (Thompson and Subar, 2013), the need for a trained professional or automated electronic program to prompt for detail (Magarey et al., 2011a) and reliance on memory (Thompson and Subar, 2013) and appropriate conceptualisation of portion sizes (Margetts and Nelson, 1997). Describing portion sizes accurately, particularly from memory, can be a complex task for adolescents (Livingstone and Robson, 2000). It is unclear whether the use of aids such as food models or household measures are useful in assisting with recall of portion size estimation (Livingstone and Robson, 2000).
Table 2.2 Comparison of dietary assessment methods

<table>
<thead>
<tr>
<th>Dietary assessment method</th>
<th>Description</th>
<th>Main sources of error</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Best use</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-hour recall</td>
<td>Captures detailed information regarding all foods and beverages consumed by the respondent the previous day; typically uses multiple passes to collect detailed information about foods consumed and to enhance accuracy and completeness; traditionally interviewer-administered but self-administered systems are now available</td>
<td>•Random error, primarily driven by day-to-day variation in intakes</td>
<td>•Provides detailed intake data to examine many aspects of diet •Provides estimate of energy and nutrient intake •Comparability between studies •Medium subject burden for repeated recalls •No literacy requirements</td>
<td>•Requires trained administrator, although new computer aided software is becoming increasingly available •Reliant on memory •Can be time consuming for administrator •Often under-estimates intake •Does not account for variation in diet •Requires appropriate conceptualisation of portion size •Does not assess eating behaviours</td>
<td>Intervention studies</td>
</tr>
</tbody>
</table>
| Food frequency questionnaire | Consists of a finite list of foods and beverages with response categories to indicate usual frequency of consumption (and possibly usual portion size) over the time period queried (e.g., past month or past year); for assessment of the total diet, the number of foods typically ranges from 80 to 120; typically self-administered | • Systematic error (bias), driven by lack of detail and error inherent in cognitive task of estimating usual intake over a period of time | • Less time burden for participant  
• Quick to mark - can be done by a computer  
• Inexpensive | • No comparability between studies unless same FFQ is used  
• Often over-estimates intake  
• Cannot assess energy and nutrient intake at the individual level | Observational studies with a focus on a number of eating behaviours or consumption of specific foods  
Can be used to rank subjects |
| --- | --- | --- | --- | --- | --- |
| Food record/diary | A self-reported, real-time accounting of all foods and beverages consumed by the respondent on one or more days; portion size may be estimated or weighed | • Random error, primarily driven by day-to-day variation in intakes  
• Reactivity bias, in which the respondent changes his/her intake behaviour or reported intake in response to the act of recording | • Detailed intake data to examine many aspects of diet  
• Provides estimate of energy and nutrient intake.  
• Comparability between studies  
• Can use household measures or weight to record portion size | • Time consuming for data entry  
• Respondent burden  
• Often under-estimates intake  
• Eating habits may be influenced by act of recording  
• Cannot assess past frequency of eating behaviours | Intervention studies |
| Screener | A short food frequency type of questionnaire, usually without portion size questions or a short behavioural type of questionnaire that asks about general dietary practices, for example, do you generally butter your bread? Typically self-administered. Single-item questions and pairs of questions are also employed to assess intake; for example, by asking about typical amount or frequency of consumption of fruit or vegetables, or frequency of consumption of fast food. | • Systematic error (bias), driven by lack of detail and error inherent in cognitive task of estimating usual intake over a period of time. • The resulting data are likely to be biased because of a lack of detail and the difficulty inherent in estimating usual consumption | • Low burden • Quick to complete • Inexpensive | • No comparability between studies unless same screener is used • Reduced statistical power | Observational studies with a focus on frequency or engagement in only one or two dietary behaviours. Observational studies assessing frequency of one behaviour of interest. |

Table adapted from Kirkpatrick et al. (2014). Additional data from Thompson and Subar (2013).
2.1.4.2.2  Food frequency questionnaire

A food frequency questionnaire (FFQ) is a dietary assessment method that asks about the frequency of consumption of certain foods and beverages during a certain period (Thompson and Subar, 2013). A FFQ is designed to be completed by the subject and the foods listed in the questionnaire will depend on the aim of the research (Rutishauser, 2005). Retrospective data collected using the FFQ is pooled and used to estimate energy or nutrient intake over the designated period (Thompson et al., 2004, Thompson and Subar, 2013). Some FFQs include questions about portion size, whilst others use an assumed or standard serving size to estimate intake (Thompson and Subar, 2013). Food frequency questionnaires can be used to rank subjects based on reported intake. The benefits of an FFQ, as shown in Table 2.2, include the low cost, ease of administration, low staff burden and capacity to use with large groups of subjects (Thompson and Subar, 2013, Rutishauser, 2005). The disadvantages of an FFQ include reliance on long-term memory, lack of detailed intake data available for analysis, and considerable level of measurement error (Thompson and Subar, 2013). Food frequency questionnaires can also overestimate energy, nutrient or food group intakes when compared to food records or 24 hour dietary recalls (Watson et al., 2009, Ambrosini et al., 2011, Block et al., 1992, Di Noia and Contento, 2009). In Australia, the need for a dietary assessment method to suit large epidemiological studies led to the development of a 135-item self-administered, semi-quantitative FFQ known as the Australian Child and Adolescent Eating Survey (Watson et al., 2009). This FFQ has been used in one adolescent intervention (Collins et al., 2013), but mostly in interventions targeting younger children (Morgan et al., 2014, Burrows et al., 2011, Burrows et al., 2013).

2.1.4.2.3  Food record

Weighed or estimated food records require the subject to record their intake at the time of consumption and describe both food detail and portion size (Rutishauser, 2005). Weighed food records require subjects to weigh all foods consumed, and adjust the record for any foods weighed but not eaten (Rutishauser, 2005). However, the weighed version is not a widely used method of dietary assessment.
given the high burden (Rutishauser, 2005). Estimated food records require the subject to estimate portion sizes of food, often using household measures such as cups and spoons (Rutishauser, 2005). Food records have been used extensively in research to monitor the effectiveness of dietary interventions (Margetts and Nelson, 1997) and allow for detailed analysis of eating occasions, timing of eating and the variability in foods eaten on different days (Thompson and Subar, 2013). Food records can also be used in interventions as a self-monitoring tool to increase adolescent awareness of consumption habits (Thompson and Subar, 2013). The benefits of food records, as shown in Table 2.2, include no reliance on memory if completed at the time of eating (Magarey et al., 2011a), provision of detailed dietary data and ability to account for daily variation if kept for more than one day (Beechy et al., 2012, Margetts and Nelson, 1997). The disadvantages of food records include the impact of recording intake on food choices (Thompson and Subar, 2013, Burrows et al., 2010), and high levels of participant burden, particularly for adolescents who snack frequently during the day (Livingstone and Robson, 2000). Food records tend to underestimate energy intake in adolescents (Collins et al., 2010), particularly over increasing lengths of time (Livingstone and Robson, 2000). However, it is possible to identify the presence of underreporting and select an appropriate method to minimise the impact on the data (such as excluding participants or performing appropriate statistical adjustments), and this is discussed further in section 2.1.4.4.

2.1.4.2.4 Brief screening tool

Brief screening tools, often with only one or two questions, can also be used as a proxy measure of diet (Thompson and Subar, 2013). These are often used with large cross-sectional samples or in epidemiological studies (Thompson and Subar, 2013). The benefits of brief screening tools, as shown in Table 2.2, are the speed of administration and low cost associated with use. The disadvantages include the ability to only measure a limited aspect of diet (Thompson and Subar, 2013), an unknown level of systematic error (Kirkpatrick et al., 2014) and the need for appropriate conceptualisation skills to determine the frequency of engaging in dietary behaviours. Thus, brief screening tools may not be the most appropriate
method to measure dietary change in adolescents (Thompson and Subar, 2013), but may be useful in combination with a more robust assessment method.

### 2.1.4.2.5 Summary of dietary assessment methods

Different dietary assessment methods are suited to different target groups and research questions. Studies reviewed by Burrows et al. (2010) found that most dietary assessment methods used in children and adolescents provided a reasonably valid measure of energy intake at the group level, but not necessarily at an individual level. When considering individual dietary change as an outcome variable for intervention research, more robust dietary assessment methods such as the 24-hour dietary recall or food record may be more suitable to estimate energy intake. It has also been recommended that two methods of dietary assessment be used in combination to collect detailed information about intake, as well as longer-term eating behaviours (Collins et al., 2010).

### 2.1.4.3 Dietary measurement error

The types of errors associated with dietary measurement can be broadly divided into random or systematic errors of misreporting (Kirkpatrick et al., 2014). Random errors vary between observations and are scattered around the true value in varying directions (Kirkpatrick, 2011). Systematic errors occur in the same direction, often due to measurement error, and reduce accuracy of the estimate, hence the likelihood for a false finding is increased (Kirkpatrick, 2011). Food frequency questionnaires and brief screening tools are thought to be most susceptible to systematic errors, while food records and 24-hour recalls are reported to be more susceptible to random errors (Kirkpatrick et al., 2014). Reviews of the dietary reporting literature have concluded that researchers need to minimise error where possible (Burrows et al., 2010, Collins et al., 2010, Magarey et al., 2011a). This can be difficult given the lack of dietary assessment methods appropriate for the particular requirements of different trials, such as the unique needs of the study population, research budget, issues with subject burden, the amount of time available for dietary assessment and the outcomes of interest (Kirkpatrick et al., 2014). Despite this, it is generally accepted that systematic bias should be eliminated and random error reduced, where possible.
Most dietary assessment methods require subjects to report their own intake, which can lead to misreported dietary intake (Kristal et al., 1994, Forrestal, 2011, Rutishauser, 2005). Misreporting includes both overreporting (reporting more than what was, or what usually is consumed) and underreporting (consuming less than what was, or what usually is consumed) (Forrestal, 2011). Misreporting may include errors with portion estimation (Hernandez et al., 2006, Ovaskainen et al., 2008), poor recall or deliberate omission/inclusion of certain foods (Krebs-Smith et al., 2000). It can also include accurately reported intakes that differ from habitual eating patterns, for example during special events (Livingstone and Black, 2003). For all dietary data collection, the impact of misreporting needs to be minimised where possible.

Given the reliance on self-reported dietary intake, there is potential for significant error in dietary data (Kristal et al., 1994, Forrestal, 2011). Random errors will decrease precision of measurements and can be overcome with increasing numbers of observations including both increased number of participants and number of assessments per participant (Rutishauser, 2005). Errors associated with dietary assessment are often systematic and lead to reporter bias in results which cannot be compensated by larger sample numbers (Rutishauser, 2005). For example, overweight participants may be more likely to underreport energy dense junk food (Krebs-Smith et al., 2000). There is evidence to suggest that subjects who report low energy intakes are likely to report less frequent consumption of certain foods including confectionaries and soft drinks (Murakami et al., 2012, Lioret et al., 2011), and are likely to report smaller portion sizes (Krebs-Smith et al., 2000, Rangan et al., 2014). These errors may lead to inaccurate estimates of the diet and disease relationship (Singh et al., 2009, Forrestal, 2011), and make it difficult to replicate findings (Burrows et al., 2012). Within random and systematic errors, there are also within-person errors and between person errors (Willett, 2013). Examples of random within-person errors include typical differences in day-to-day intake and examples of systematic within-person error include misinterpretation of a questionnaire, or inaccurate reporting related to personal factors. Random between-person errors can result from using only one measurement of intake at a
time when within-person error is also present, although this is balanced out by other people in the population (Willett, 2013). In this case the mean is estimated without bias but the variance is increased. Finally, systematic between-person error may result if there is an error in recording for a certain item that is used to rank subjects, such as one portion size option that is entered incorrectly and only affects those who reported that portion size (Willett, 2013).

Systematic errors may be occurring in epidemiological studies that show a lower or equal self-report of intake in overweight individuals when compared to healthy weight individuals, despite the trends in weight gain in the overweight group (Forrestal, 2011, Rennie et al., 2005). Thus, errors associated with dietary assessment methods need to be considered in the selection of such dietary assessment methods (Rockett and Colditz, 1997) and attempts made to quantify and adjust for the bias associated with misreporting (Forrestal, 2011).

2.1.4.4 Identifying underreporting

There are a number of methods proposed to determine the effect and level of misreporting in dietary intake data (Forrestal, 2011). Historically, the validity of dietary intake measurement has been determined through comparison with other dietary assessment methods, which inevitably have their own source of error (Burrows et al., 2010). This is often referred to as calibration (Livingstone and Black, 2003) but as this approach does not provide an objective reference, it should no longer be used to validate intake (Forrestal, 2011).

To address the issue of measurement error, researchers measure ‘biomarkers’ as an objective comparison for dietary intake. Nutritional biomarkers are measurable objective indicators of a biological state and can be used to estimate dietary intake (Bingham, 2002). Common biomarkers include doubly labelled water, urinary nitrogen, and plasma carotenoids. Biomarkers are able to validate dietary assessment measures because their presence or levels in the body are directly related to dietary intake, but are limited to validating one aspect or nutrient at a time (Collins et al., 2010). For example, a predictable relationship exists between dietary nitrogen (from protein) and urinary nitrogen excretion. Thus, urinary
nitrogen can be objectively measured and used to provide a comparison for protein intake (Rutishauser, 2005). Comparison of dietary assessment methods with objective biochemical markers can be expensive and impractical when each marker only provides an indicator of a small component of total dietary intake (Margetts and Nelson, 1997).

Doubly labelled water is a biomarker used to validate reported energy intake (Rutishauser, 2005, Collins et al., 2010). The process of collecting doubly labelled water data involves ingestion of water labelled with a known quantity of hydrogen and oxygen isotopes. The elimination of these isotopes is measured from serial urine collections over several days and used to calculate energy expenditure. Studies using doubly labelled water in children and adolescents have found food records to underestimate energy intake by 20-31% when compared to energy expenditure assessed by doubly labelled water (Forrestal, 2011, McPherson et al., 2000). In overweight adolescents, Bandini et al. (1990) described a rate of underreporting of 42% compared to 20% in healthy weight adolescents. In this study, energy intake was measured using 14 day food records and compared with energy expenditure measured using doubly labelled water. In a three week metabolic study, overweight adolescents underreported intake using food records by 35 (SD 20)%, as measured by doubly labelled water (Singh et al., 2009). This study was completed at a summer research camp, and subjects’ intake was controlled to provide a specific amount of each macronutrient, as a percentage of total energy. Interestingly, there was no significant association observed between underreporting and the self-reported macronutrient contribution to energy, suggesting that underreporting of all of the macronutrients contributed to total energy underreporting. Although doubly labelled water can be useful in identifying levels of underreporting, it is not routinely used given the expense, lack of analysis availability and burden for subjects (Goris et al., 2001a). Collection of two dietary assessment methods and one dietary biomarker has been proposed to evaluate dietary intake and identify the extent of underreporting in the context of childhood obesity (Collins et al., 2010). However, cost and burden currently limits the use of
biomarkers (Margetts and Nelson, 1997), particularly in community-based intervention studies.

Energy intake is considered to be a useful indicator of total food intake, and if this is underestimated, then other associated nutrient intakes (macronutrients, minerals and B vitamins) are likely to be underestimated (Livingstone and Black, 2003). Energy intake can be compared with energy expenditure and used to provide an indication of the levels of misreporting of intake and hence the general quality of the dietary data (Livingstone and Black, 2003).

Methods for estimating energy expenditure, other than doubly labelled water, include standardised equations that predict resting metabolic rate based on weight, height and some estimation of habitual physical activity. However, these can overestimate energy expenditure if physical activity levels are not objectively assessed, particularly because of a lack of clearly defined physical activity factors for adolescents (Hofsteenge et al., 2010). Activity levels can be measured in activity diaries and questionnaires used in conjunction with resting metabolic rate estimations, however, these measures often have their own level of reporting error further compounding error of the estimates (Goris et al., 2001a, Livingstone and Black, 2003). Accelerometry provides a more objective measure of energy expended through physical activity and can be used together with an equation that estimates resting metabolic rate to estimate total energy expenditure (Goris et al., 2001a).

Very few studies have used accelerometry to estimate physical activity levels in adolescents. Noel et al. (2010) compared different methods of estimating physical activity coefficients in a group of 2,868 adolescents aged 13 years. In this study, adolescents recorded their dietary intake using three day food records and wore accelerometers for seven days. In the first method, accelerometer counts were used to classify time spent in moderate and vigorous physical activity to create the physical activity coefficient. In a second method, accelerometer data was used to estimate physical activity levels and collapsed to a physical activity coefficient. This study used an equation defined by Huang et al. (2005) to identify unacceptably low levels of reported energy intake as compared to predicted energy requirements. For
the first method, the plausibility range of reported energy intake as a percentage of predicted energy requirements was 79-121% for girls and 81-119% for boys. Using the second method, the plausibility range was 96-104% for girls and 97-103% for boys. The methods described did not show a high level of agreement, although both showed separately high levels of agreement to the original equation by Huang et al. (2005) using estimated PAL. Both methods of identifying underreporting showed higher BMI in people who underreported. Using the first method, 37% of adolescents were identified as underreporters and using the second method 52% were identified as underreporters. It was suggested that using the MVPA method might underestimate the extent of underreporting (Noel et al., 2010).

Another study estimated the prevalence of misreporting in a dietary questionnaire of 481 Swedish adolescents aged 16-17 years (Vagstrand et al., 2009). A physical activity questionnaire was used to measure physical activity for all participants and they were divided into three groups based on estimated energy expenditure. Activity monitors were used in a sub-group of 47 adolescents to estimate physical activity levels. In this study, the established methods were used to determine a confidence interval (2 standard deviations) specific for girls and boys in each of the three groups (Goldberg et al., 1991). Adolescents were then classified as low energy reporters, adequate energy reporters and high energy reporters. This method identified 16% of girls as low energy reporters and 13% of boys as low energy reporters. There was a significant trend for BMI to increase from high energy reporters to low energy reporters in this group. These studies show that estimating activity energy expenditure from accelerometers is a useful way to reduce error in the measurement of underreporting.

The identification of implausible intakes has been traditionally assessed using a method proposed by Goldberg et al. (1991). This method has been used to highlight a lack of agreement between energy expenditure and reported energy intake. In this approach energy intake is expressed as a multiple of basal metabolic rate and compared to energy expenditure also expressed as a multiple of basal metabolic rate. When expressed like this, energy expenditure reflects physical activity level. In early application of the Goldberg method in adults, a pre-determined level of
physical activity level was used. Originally, this estimate came from a number of studies using calorimeters to measure energy expenditure and physical activity levels of adults in a laboratory setting. To compare intake and expenditure, the Goldberg et al. (1991) method uses a specific equation that accounts for measurement errors to calculate a threshold for implausibility that represents approximately two standard deviations of the level of agreement between energy intake (as a multiple of basal metabolic rate) and the chosen physical activity level. If the reported energy intake (as a multiple of basal metabolic rate) fell outside the two standard deviations or cut-offs, this indicated that the intake was likely to be implausible. Thus, anything below or above the two standard deviation cut-offs was excluded from the analysis.

This approach was revised by Black (2000) to replace the use of a single low standard estimate of physical activity levels with a population specific estimate (Black, 2000). The revised methods based on population specific cut-offs can be used to identify implausible reports that fall outside the two standard deviation limit. In adults, these cut-offs have been used to identify implausible energy intakes in 39% of women and 27% of men in a general population sample (Krebs-Smith et al., 2000). However, there are several limitations to the use of these cut-offs, including poor sensitivity at the individual level (Black, 2000), an inability to identify different levels of underreporting with only extreme underreporting identified (Thompson and Subar, 2013) and a reliance on estimates of physical activity, which introduces further sources of error (Goris et al., 2001a). Further, the use of these cut-offs is not recommended in children and adolescents due to a loss in sensitivity (Livingstone et al., 2003) and tendency to underestimate the level of underreporting (Livingstone et al., 2004).

Alternative methods to identify implausible reporting in children and adolescents have been proposed by McCrory et al. (2002) to compensate for some of the limitations of the Goldberg method. The McCrory et al. (2002) method compares the difference between predicted total energy expenditure and self-reported energy intake, and accounts for within subject errors. This approach does not rely on estimation of physical activity levels but rather estimates total energy
expenditure using predictive equations from the Institute of Medicine. This is a potential limitation given the predictive equations do not account for different levels of physical activity that will ultimately influence energy expenditure. Further, McCrory et al. (2002) have suggested using a stricter cut-off of only one standard deviation to identify underreporting, as compared to the two standard deviations proposed by Goldberg et al. (1991). These new cut-offs were applied in a cross-sectional study of 381 adolescents (12-19 years) of all weight statuses, who reported dietary intake using 24-hour recalls (Huang et al., 2004). Unsurprisingly, the use of stricter cut-offs resulted in a large proportion of adolescents (57%) identified as providing implausible reports of energy intake (Huang et al., 2004). The main limitation associated with this method is the high proportion of the sample which will be likely excluded from analyses, introducing a source of bias from a non-representative sample and potential systematic bias resulting from those excluded. Further application in large epidemiological studies have shown that using only the plausible reporter sub-sample does change the associations between diet and other outcomes (Huang et al., 2004, Huang et al., 2005, McCrory et al., 2002).

It has been argued that including people who underreport in dietary analysis has the potential to bias results and misconstrue diet and disease relationships (McCrory et al., 2002, Huang et al., 2005). Whilst this may be true, subjects who underreport are often more likely to be overweight (Thompson and Subar, 2013) so exclusion will only introduce a new form of bias (Rennie et al., 2007). In cross-sectional analyses of diet, attempts can be made to minimise the likelihood of underreporting through the use of appropriate dietary assessment methods and subject training, although underreporting is usually adjusted for by excluding subjects who report low-energy intakes (Rennie et al., 2007). Statistical corrections for energy intake have been proposed, however, this also does not account for selective underreporting of nutrients or food groups (Collins et al., 2010). To account for some of these limitations, it has been proposed that in the context of an intervention, reported intake can be analysed using the level of underreporting as a covariate to adjust for the bias in repeated measures analysis (Jennings et al., 2012). This method retains all subjects, but statistically adjusts for the factor of
underreporting, thus minimizing overall bias from self-reported dietary assessments.

Underreporting of dietary intake is a common phenomenon and has the potential to influence relationships between diet and disease. There are a number of options available to assess the extent of underreporting in dietary data, yet there remains a lack of an ideal method to use with data from overweight adolescents.

2.1.4.5 Factors associated with underreporting
Across the lifespan an increased rate of underreporting, as determined by doubly labelled water studies and comparison of reported energy intake to energy requirements, has regularly been associated with increasing adiposity (Bandini et al., 1990, Champagne et al., 1998, Singh et al., 2009, Rangan et al., 2011), increasing age in children (Livingstone and Black, 2003, Forrestal, 2011, Livingstone and Robson, 2000) and female gender (Ferrari et al., 2002, Yannakoulia et al., 2007). The dietary assessment methods used can also relate to underreporting. For example, the quality of reporting using food records decreases with the number of recording days (Thompson and Subar, 2013), thus increased levels of underreporting are likely in long-term studies, possibly relating to the burden of data collection (Goris et al., 2001b).

2.1.4.5.1 Adolescent underreporting risk factors
Adolescents are reported to be a particularly hard group from which to collect detailed and accurate dietary data (Livingstone and Black, 2003, Livingstone and Robson, 2000). Factors associated with misreporting in adolescents including lack of motivation (Livingstone and Robson, 2000, Bratteby et al., 1998), body image concerns (Noel et al., 2010), rebellion against authority and unstructured eating habits (Livingstone et al., 2006, Livingstone and Black, 2003, Boushey et al., 2009, Bandini et al., 2003, Forrestal, 2011, Livingstone and Robson, 2000). Underreporting in adolescence appears to be related to similar factors as underreporting in adults. Overweight adolescents are more likely than healthy weight adolescents to underreport dietary intake (Rangan et al., 2011, Forrestal, 2011, Livingstone and Robson, 2000, Lioret et al., 2011, Murakami et al., 2012). Older adolescents are
more likely to underreport their intake than younger children (Livingstone and Robson, 2000, Forrestal, 2011, Rangan et al., 2014, Murakami et al., 2012). Gender does not appear to be a strong predictor of underreporting in adolescents, however, it does seem to have a moderating effect with high levels of underreporting in female adolescents who are older and more overweight (Forrestal, 2011). In view of these known risk factors, dietary assessment is likely to include some level of underreporting, which needs to be reported and accounted for in analysis (Beaton, 1994).

2.1.4.6 Improving the quality of dietary data
To improve the quality of dietary data, reviews of the literature indicate that researchers need to select appropriate methods tailored to their specific outcomes (Livingstone and Robson, 2000, Kristal et al., 1994) and provide a rationale for choosing the particular method of dietary assessment (Burrows et al., 2012). Recommendations for dietary assessment processes include, encouraging reporting of brand names (Thompson and Subar, 2013), reporting food composition databases used (Burrows et al., 2012), describing dietitian involvement in data collection (Burrows et al., 2012) and presenting macronutrient results as a percentage of total energy intake (Hirvonen et al., 1997). In addition, a review by Forrestal (2011) concluded that every dietary assessment project should attempt to quantify the bias of their results and present the proportion of underreporters and plausible reporters to give context to the results. There remains a lack of clear evidence to support a specific method for accounting for underreporting, so justification should be provided for the method chosen.

2.1.4.7 Dietary assessment in overweight adolescent intervention studies
Dietary data collection methods differ between previously reported overweight adolescent intervention trials. In studies that included a dietary component, there have been a number of different methods employed to assess dietary intake changes following intervention including 24-hour recalls (Bean et al., 2011, Eliakim et al., 2002, DeBar et al., 2012, Kitzman-Ulrich et al., 2009), FFQs (Nguyen et al., 2013, Tsiros et al., 2008, Janicke et al., 2008a, Wengle et al., 2011, Kong et al.,
modified questionnaires (Lubans et al., 2011), two day food records (Nemet et al., 2006), three day food records (Davis et al., 2011, Karner-Rezek et al., 2013), four day food records (Ball et al., 2011, Wengle et al., 2011), two day recalls (Saelens et al., 2002), three day recalls (Park et al., 2007), percentage of nutrition journals completed (Lloyd-Richardson et al., 2012), a 7 day diary for frequency of consumption of certain foods (Coppins et al., 2011), Dutch Eating Behaviour Questionnaire (Sarvestani et al., 2009) and brief dietary assessment tools not otherwise described (Shaibi et al., 2012). For some trials measures were not described (Woolford et al., 2011b, Resnicow et al., 2005), or there was no measure of dietary intake (Steele et al., 2012, Kalarchian et al., 2009, Weigel et al., 2008, Diaz et al., 2010, Jiang et al., 2005, Rynders et al., 2012, Burguera et al., 2011, Savoye et al., 2011, Johnston et al., 2007, Panagiotopoulos et al., 2011, Kubicky et al., 2012, Knopfli et al., 2008, Kolsgaard et al., 2011). There are clearly a large number of approaches to measuring dietary intake and assessment methods need to be suited to reporting the key outcomes of the intervention (Collins et al., 2010). The dearth of comprehensive dietary data in overweight adolescents highlights the need for future interventions to use assessment methods that will provide adequate detail of intake and how this can change following intervention. There are a large number of studies using short questionnaires to report dietary intake and change, however, these methods will not be able to provide the level of detail required to inform future interventions.

### 2.1.4.7.1 Identification of underreporting in overweight adolescent intervention studies

Of the studies listed above, only a small number have estimated the likelihood of underreporting by participants and fewer have addressed it in analyses. Bean et al. (2011) offered the most in-depth analysis in the estimation of the ratio of energy intake to basal metabolic rate. The EI:BMR ratio was 1.02 at baseline and this ratio had decreased at 6 months to 0.80. The authors describe this reduction as expected and suggested it was evidence for reducing energy intake, as the adolescents were still participating in the intervention. However, this is not a common interpretation of the EI:BMR ratio as there is no accounting for the potential that this ratio reflects
greater underreporting. The authors also describe anthropometric changes that support reductions in energy intake, such as a BMI z-score reduction and blood lipid changes consistent with reported fat intake changes.

A greater number of studies did not address underreporting at all, (Kitzman-Ulrich et al., 2009, Coppins et al., 2011, Wengle et al., 2011, DeBar et al., 2012, Nemet et al., 2006, Tsiros et al., 2008, Shaibi et al., 2012, Janicke et al., 2008a, Nguyen et al., 2012b, Davis et al., 2009b, Lubans et al., 2011, Karner-Rezek et al., 2013, Kong et al., 2013, Ball et al., 2011, Park et al., 2007, Saelens et al., 2002). The two remaining studies used methods that did not relate to energy intake, specifically the Dutch Eating Behaviour Questionnaire (Sarvestani et al., 2009) and the percentage of nutrition journals completed (Lloyd-Richardson et al., 2012), and thus underreporting cannot be measured in these studies. In addition, only three studies explained the limitations associated with dietary assessment or acknowledged the impact of adolescents wanting to provide socially-desirable reports of change in line with the intervention messages. Saelens et al. (2002) used a two day dietary recall to assess diet and measured consistency estimate across the two days to show moderate correlations between the days. These authors did not further analyse the data for underreporting but acknowledged that the data was likely limited by a desire for adolescents to report socially acceptable intakes. Kitzman-Ulrich et al. (2009) acknowledged the variability in adolescent recalls, but this was not accounted for and the authors appear to have drawn their overall conclusions from these known biased results. Coppins et al. (2011) acknowledged the likelihood of underreporting in this group and concluded that the results might not be accurate. Thus, results from most of the studies in overweight adolescent interventions must be considered with caution.

2.1.4.8 Summary of dietary assessment in overweight adolescents

There are very few trials conducted with overweight adolescents that have collected and reported detailed participant dietary intake data (Ho et al., 2013), perhaps due to the difficulties associated with dietary data collection in overweight adolescents. This has led to a significant gap in the evidence about dietary intake in overweight and obese adolescents, and the ability to measure the effectiveness of
interventions (Ho et al., 2013). The lack of consistent dietary assessment and inadequate methods of dealing with underreporting makes it difficult to compare findings between trials (Collins et al., 2010). Without this data, it remains unclear which dietary assessment methods are best suited to overweight adolescents and what researchers can expect to observe changes in following intervention. This information is critical to the development of future tailored dietary interventions to treat adolescent obesity (Collins et al., 2007).

The second part of this literature review considers the options for the design of multicomponent interventions for overweight adolescents and reviews the implementation of such interventions. This is followed by the third part which reviews the outcomes reported in multicomponent interventions while highlighting remaining gaps in the literature. This third part also includes a summary of key multicomponent interventions including a dietary component, similar to the intervention being evaluated in this thesis, which are described in greater detail.

2.2 Background for adolescent obesity interventions

A number of recommendations have been made for the best way to intervene with overweight and obese adolescents (Oude Luttikhuis et al., 2009, Barlow, 2007, Steinbeck, 2005). Further, a number of factors are considered best practice, such as including the whole family and covering key components of healthy eating, physical activity and behaviour modification. However, there are also a number of other factors that may be useful to consider that allow for some flexibility between optimal trial designs. For example, the application of suitable theories, the setting, and the selection of assessment measures can be tailored to best suit the target audience. In relation to the actual intervention there are a number of other factors to consider, including design of the dietary intervention and maintenance support program. The evidence to date does not suggest there is just one ideal way to intervene with overweight adolescents, so interventions should be designed to suit their target group based on the existing evidence and particular intervention circumstances. The main aspects of intervention design are reviewed below, with a
focus on interventions that include a dietary component. The outcomes of these studies are reviewed in detail in the subsequent section.

2.2.1 Family involvement

The most recent Cochrane Review of interventions for treating childhood obesity (including adolescent obesity) suggests promoting a healthy lifestyle through a family-based program as the most effective way to manage overweight and obesity during adolescence (Oude Luttikhuis et al., 2009). Other reviews of the literature confirm that parents play a critical role in obesity treatment (Barlow, 2007, Stewart et al., 2009, Shrewsbury et al., 2011b) and have the potential to model healthy behaviours and create supportive environments for healthy change (Gruber and Haldeman, 2009, Raynor et al., 2011, Sandvik et al., 2010, Pearson et al., 2009c). The specific role and extent of parent involvement in adolescent obesity intervention has not been clearly defined (Shrewsbury et al., 2011b), and currently relies on the best judgement of the clinician or multi-disciplinary team involved with the family. Development of clearly defined parent roles in obesity treatment has recently been described based on self-determination and goal setting theories (Fenner et al., 2013). Regardless of the role, outcomes have been shown to be improved when the whole family are involved in lifestyle change, as opposed to just the adolescent (Epstein et al., 1994).

2.2.2 Multi-component intervention

Multi-component lifestyle interventions including healthy eating, physical activity and psychosocial components are well accepted as a treatment for adolescent obesity (National Health and Medical Research Council, 2013b, Oude Luttikhuis et al., 2009, Ho et al., 2012, American Dietetic Association, 2006). Clinical practice guidelines recommend an approach to achieve reduced energy intake, increased physical activity, and reduced sedentary activity as supported by some form of behaviour change techniques (i.e. goal setting) (National Health and Medical Research Council, 2013b, Martin et al., 2014). To support the delivery of multi-component interventions, national guidelines also advocate for multi-disciplinary care during active weight management (National Health and Medical Research Council, 2013b). This reflects the multi-faceted nature of obesity development and
progression, and the need for specialised skill and support across different aspects of obesity management. The Clinical practice guidelines for the management of overweight and obesity in adults, adolescents and children in Australia recommend that at the most basic level, all health professionals involved should have a good understanding of the medical and psychosocial needs of overweight and obese adolescents and their families, with discipline-specific skills in supporting lifestyle change and managing co-morbidities (National Health and Medical Research Council, 2013b). A recent review of the literature has suggested that clinicians should also be trained in the implementation of behavioural change techniques to best support adolescents to achieve the main goals of treatment (Stewart et al., 2009).

2.2.3 Use of theory in intervention design

Theoretical frameworks are used to explain behaviour and potential for change and hence provide a solid basis for the development and implementation of effective interventions (Reeves et al., 2008, Cerin et al., 2009). There are strong directives in the literature for research to be based on sound theories, however there is no commonly accepted theory used consistently in adolescent obesity treatment (Cerin et al., 2009). A recent review of the literature highlights the lack of well described theories employed in obesity research (AlMarzooqi and Nagy, 2011). Common theories used in child and adolescent obesity interventions include social cognitive theory (Bandura, 1986), health belief model (Janz and Becker, 1984) and ecologic systems theory (Bronfenbrenner, 1977, Davison and Birch, 2001). These theories and their application in overweight adolescent studies are described below, however the outcomes from these trials are discussed together in detail in section 2.3.

Social cognitive theory suggests that humans adopt new behaviours by observing and learning from others in the context of their environment (Bandura, 1986). Concepts of self-efficacy, that is the belief in one’s own capacity to achieve goals, and goal setting are incorporated within the social cognitive theory framework (Bandura, 2001). A number of adolescent obesity interventions have adopted social cognitive theory (Lubans et al., 2011, Lloyd-Richardson et al., 2012, Shrewsbury et
al., 2009) with others combining social cognitive theory with the eco-developmental theory (Shaibi et al., 2012) or Family Systems Theory (Kitzman-Ulrich et al., 2009).

The health belief model posits that an individual’s perception of a health problem, and the perceived barriers and enablers to change, can be used to explain behaviour (Janz and Becker, 1984). Similarly to social cognitive theory, this model incorporates the concept of self-efficacy as an important pre-cursor to change. Only one recent study has used this model (Diaz et al., 2010), likely because it does not account for the influence of the environment or the emotional nature of some health behaviours (Glanz et al., 2002).

The trans-theoretical model of behaviour change can be used to explain participants’ readiness to change, to allow for the tailoring of interventions to suit participant needs (Prochaska et al., 1992). The stages begin at pre-contemplation, then cycle through contemplation, preparation, action and maintenance (Prochaska et al., 1992). This model has only been used in one recent adolescent obesity trial in a school setting (Kong et al., 2013). However, a recent Cochrane review found little evidence to support the use of this theory in obesity management in adults (Tuah et al., 2011).

Self-determination theory highlights the importance of intrinsic motivation to precede behaviour change (Deci and Ryan, 2000). This theory maintains the need for adolescents to feel a sense of autonomy, relatedness and competence before their behaviour can be self-motivated (Deci and Ryan, 2000). Preliminary work in this field has been undertaken in a small number of studies of overweight and obese adolescents with good effect (Steele et al., 2012, Woolford et al., 2011b).

### 2.2.3.1 Theoretical components used in interventions for overweight adolescents

A number of interventions do not describe the use of a specific theory, but allude to the use of behavioural change techniques often derived from a theoretical framework. These techniques include goal setting, self-monitoring, coping skills and changing the home environment (Janicke et al., 2008a, Savoye et al., 2007, Wengle et al., 2011, Burnet et al., 2011, DeBar et al., 2012, Park et al., 2007, Saelens et al.,
Similarly, other interventions describe approaches to counselling like motivational interviewing (Davis et al., 2011, Resnicow et al., 2005) or cognitive behavioural therapy (Bean et al., 2011, Tsiros et al., 2008) or both (Ball et al., 2011) but do not combine this with a theoretical framework.

Several other studies of adolescent obesity interventions do not describe the use of a particular theory or behavioural approach (Eliakim et al., 2002, Reinehr et al., 2010, Jiang et al., 2005, Rynders et al., 2012, Nemet et al., 2006, Kubicky et al., 2012, Karner-Rezek et al., 2013, Kolsgaard et al., 2011). This lack of detail regarding the theoretical basis of an intervention is a serious limitation in much of the adolescent obesity research, as it reduces the ability of researchers to explain any observed changes (Cerin et al., 2009, Abraham and Michie, 2008).

### 2.2.3.2 Summary of theories used with overweight adolescents

The literature shows that a number of different studies have incorporated many different theoretical foundations to guide program development. To date, there is insufficient evidence to promote the use of one theory over another when working with overweight adolescents. However, it has been proposed that the more commonly-used theories of behaviour change are potentially limited by their inability to predict the non-linear nature of behaviour change or account for the multitude of factors that influence the condition and treatment (Resnicow and Vaughan, 2006). Recent research into intrinsic theories like self-determination theory has the potential to be useful in this field (Deci and Ryan, 2000, Fenner et al., 2013).

### 2.2.4 Weight versus behaviour focus

It is unclear from the literature as to whether adolescent obesity interventions should have a primary focus on body weight change or the more immediate outcome of behaviour, such as diet or physical activity changes. In existing studies there appears to be a disconnect between the outcome measured and the attributable behaviours, hence there remains a lack of evidence for how to achieve
a reduction in weight. For example, the majority of trials deliver behaviour focussed interventions to overweight adolescents but have primary outcome measures only for adiposity (Shaibi et al., 2012, Janicke et al., 2008a, Shrewsbury et al., 2009, Davis et al., 2009a, Steele et al., 2012, Savoye et al., 2007, Eliakim et al., 2002, Resnicow et al., 2005, Diaz et al., 2010, Lloyd-Richardson et al., 2012, Wengle et al., 2011, DeBar et al., 2012, Park et al., 2007, Saelens et al., 2002, Weigel et al., 2008, Woolford et al., 2011b, Jiang et al., 2005, Coppins et al., 2011, Sarvestani et al., 2009, Tsiros et al., 2008, Nemet et al., 2006, Kong et al., 2013, Johnston et al., 2007, Panagiotopoulos et al., 2011, Kubicky et al., 2012, Knopfli et al., 2008, Kolsgaard et al., 2011). This is a particular issue because weight is the outcome that is not the direct focus for change in these interventions. The direct focus is usually on physical activity or dietary behaviour change, which in turn has the capacity to impact on weight. Whilst a majority of trials do have primary outcome measures relating directly to adiposity, most also measure some level of physical activity or dietary change as secondary outcomes. However, there is often an insufficient level of reporting of behavioural change. Further, the relationship between weight and behaviour is still unclear, particularly with diet as discussed in section 2.1.1, hence a focus on changing behaviour may be more appropriate. This would also allow further investigations of the mechanisms for behaviour change in overweight adolescents.

There is also extensive evidence to suggest that targeting weight and weight loss has the potential to contribute to weight stigma (Bacon and Aphramor, 2011), that is, judgement or discrimination based on one’s weight (Puhl and Heuer, 2009). Qualitative research has shown that adolescents seeking obesity-related treatment often experience the effects of weight stigmatisation in their daily lives (Puhl et al., 2013), which may be a barrier to effective intervention (Puhl and Latner, 2007). In a longitudinal study of 2516 adolescents, weight stigmatisation was identified as a risk factor for becoming overweight in adolescence (Haines et al., 2007). Further, a focus on weight or weight loss has been associated with unhealthy cycles of weight loss and regain and preoccupation with food and body size (Bacon and Aphramor, 2011). In light of the negative connotations associated with weight, a focus on
healthy behaviours may be more appropriate in healthy lifestyle programs. This is supported by evidence suggesting that dietary improvements will result in improved health outcomes (Ross and Bradshaw, 2009) and reduced risk of chronic disease (Gaesser et al., 2011), irrespective of weight change.

2.2.5 Settings
The site for the delivery of an obesity intervention might be an important factor in the effectiveness of the program (Oude Luttikhuis et al., 2009), however there is no conclusive evidence to support one setting over another. Settings may include primary care sites such as general practitioner offices, secondary care sites such as schools, community centres or research labs, and tertiary care sites such as hospitals and weight management clinics. Each setting may have advantages and disadvantages to consider to best suit the target group. The setting of an intervention is often briefly mentioned in publications, although a number of recent adolescent obesity interventions have not described their intervention site (Steele et al., 2012, Lloyd-Richardson et al., 2012, Park et al., 2007, Kitzman-Ulrich et al., 2009, Sarvestani et al., 2009). The detailed outcomes of these studies are reported together in section 2.3, so the following review only discusses the existing literature regarding settings for multicomponent adolescent interventions.

2.2.5.1 Primary care sites
Obesity treatment is often considered to be too complex and time consuming to be managed by general practitioners (Barlow, 2007), while qualitative studies have shown that primary health care workers do not feel confident in managing childhood obesity (Turner et al., 2009, Walker et al., 2007). A randomised controlled trial in younger Australian children did not support the effectiveness of a primary care intervention to improve outcomes for overweight and obese children (Wake et al., 2009). Further, delivery of multi-disciplinary care may be difficult in a primary care practice (Diaz et al., 2010). In adolescents, three studies have been delivered in a primary care setting, although all required significant input from other professionals such as a dietitian or clinical psychologist (Diaz et al., 2010, Saelens et al., 2002, DeBar et al., 2012). The outcomes of these trials are reviewed in detail in section 2.3.
2.2.5.2 Secondary care sites

Interventions delivered in schools have primarily focused on obesity prevention, rather than treatment, in groups with high risk of obesity or current high prevalence of overweight (Lubans et al., 2011, Bayne-Smith et al., 2004, Melnyk et al., 2013, Singh et al., 2007, Dewar et al., 2013). Recent evidence regarding prevention suggests some positive but modest results in this field (Kropski et al., 2008, Brown and Summerbell, 2009). However, school-based treatments for obesity have not been well-evaluated in the literature. A small number of studies have targeted overweight and obese adolescents in schools (Johnston et al., 2007, Kong et al., 2013). Other studies have used school grounds out of school time (Savoye et al., 2007, Burguera et al., 2011, Coppins et al., 2011). School-based interventions have the potential to be a barrier to participation for some adolescents who are concerned about being seen participating in a weight-related program among normal weight peers (McManus et al., 2012).

Community settings include local sites and community centres that are accessible to people who live in the area. Community interventions tailored to local populations are supported in the literature (World Health Organization, 2012), particularly if brief primary care counselling has not been successful (Barlow and Committee, 2007). Community settings can be advantageous if local stakeholders are involved, existing community structures are utilised and the intervention is accessible to local families (World Health Organization, 2009). A large proportion of adolescent obesity interventions have been implemented in a community setting (Shaibi et al., 2012, Janicke et al., 2008a, Shrewsbury et al., 2009, Resnicow et al., 2005, Olvera et al., 2010, Burnet et al., 2011, DeBar et al., 2012, Weigel et al., 2008) and some interventions have been partly run in the community (e.g., the exercise component) (Rynders et al., 2012, Coppins et al., 2011, Wengle et al., 2011).

Interventions delivered in university or laboratory setting are relatively common, but it is not known how the setting influences delivery or effectiveness of the intervention. Within these settings there is often access to high quality resources such as gym equipment or advanced assessment measures. A number of adolescent obesity interventions have been delivered in research settings (Bean et al., 2011,
Eliakim et al., 2002, Savoye et al., 2007, Reinehr et al., 2010, Tsiros et al., 2008) and the outcomes of these trials are discussed in section 2.3.

Individual-based interventions delivered by staff at the participants’ home have the potential to be time and resource intensive, and do not allow for the therapeutic effects of group treatment (Robinson, 1999). Further, there is no available evidence to support individual home-based interventions in overweight adolescents (American Dietetic Association, 2006). Only one identified intervention for overweight adolescents was delivered in the home (Jiang et al., 2005) and the outcomes of this trial are discussed in section 2.3.

2.2.5.3 Tertiary care sites
Interventions implemented in hospital or specialist weight management clinics are often reserved for adolescents with obesity plus other comorbidities. These settings often provide access to trained staff and ongoing follow-up. A number of interventions have been delivered in tertiary care settings (Woolford et al., 2011b, Ball et al., 2011, Nemet et al., 2006, Panagiotopoulos et al., 2011, Kubicky et al., 2012, Karner-Rezek et al., 2013, Knopfli et al., 2008, Kolsgaard et al., 2011), with two of these studies being delivered while the adolescents were in-patients (Karner-Rezek et al., 2013, Knopfli et al., 2008). Tertiary centres may be difficult for families to access, which may reduce participation rates (Kitscha et al., 2009, McManus et al., 2012). There is no existing evidence to support tertiary sites as a preferred option for service delivery.

2.2.6 Dietary intervention
Obesity treatment interventions typically aim to create and maintain a negative energy balance through healthy lifestyle changes to reduce energy intake (dietary changes) and/or increase energy expenditure (physical activity changes) (Barlow, 2007). In adolescents, extra consideration must be given to the increased need for good nutrition to support growth and development (Stang, 2010). Although general clinical practice guidelines exist, there is no one well-accepted method for delivering the dietary component of an obesity intervention. The following sections
of this thesis review the evidence relating to the dietary component of multicomponent interventions for overweight adolescents.

2.2.6.1 Guidelines for intervention development
Clinical practice guidelines are systematically developed to support the management of overweight and obesity and may differ between countries. The Clinical practice guidelines for the management of overweight and obesity in adults, adolescents and children in Australia were based on the most recent international guidelines and included a systematic literature review to adapt the guidelines to suit the Australian context (National Health and Medical Research Council, 2013b). Recommendations were based on evaluations of systematic reviews and randomised control trials and graded according to the level of available evidence. If sufficient evidence was not available, the expert committee discussed the level of evidence and made a consensus-based recommendation. In the Australian guidelines, further short recommendations have also been developed to guide current practice that was evolving at a faster rate than the research base.

There are a number of clinical practice guidelines across the world that suggest that within a dietary component of an obesity intervention, health professionals should promote goal setting to increase fruit and vegetable intake, reduce sweetened beverage consumption, eat a healthy breakfast, prepare meals and snacks at home and regularly eat together with family members (Barlow, 2007, Shrewsbury et al., 2011b, National Health and Medical Research Council, 2013b). Adoption of these behaviours is likely to result in a reduction in energy intake, with conflicting evidence around how this is best achieved. Some evidence suggests that strategies to reduce unhealthy behaviours seem to be more effective than those to increase healthy behaviours (Dewar et al., 2013, Kamath et al., 2008) while others have observed better outcomes following the promotion of healthy behaviours only (Epstein et al., 2001, Epstein et al., 2008).

There is potential that targets such as increased fruit and vegetable intake might not be specific enough for adolescents to change their daily behaviours, with most interventions only showing modest behaviour changes at best (Oude Luttikhuis et
al., 2009). The most recent intervention studies in youth promote these behaviours through either a healthy eating approach incorporating dietary education and skill development or, the provision of highly structured energy-restricted eating plans; with both described in the following sections. These include diets with a nutrient focus, the Traffic Light diet, dietary prescriptions and a variety of food group-based approaches.

2.2.6.1.1 Diets with a nutrient focus

Prescribing a diet with a specific macronutrient distribution to manage overweight and obesity in adolescence is not well supported by the evidence (National Health and Medical Research Council, 2013b, Gow et al., 2014). Overall reduction in energy intake appears more important than focussing on one particular macronutrient with clinical studies in adolescents showing that low carbohydrate diets (Sondike et al., 2003, Demol et al., 2009, Kirk et al., 2012, Krebs et al., 2010) and low glycaemic load diets (Mirza et al., 2013, Ebbeling CB et al., 2007) were just as effective as low fat diets in achieving weight loss and maintaining lipid profiles. However Kirk et al. (2012) suggested that low carbohydrate diets may be difficult to adhere to in the long-term due to the restrictive nature of the diet and possible side-effects. In a multi-component overweight adolescent intervention, Davis et al. (2009a) used carbohydrate and fibre recommendations to guide dietary change. The authors had pre-tested this approach in smaller pilot groups of Latino adolescents (Davis et al., 2007b, Davis et al., 2007a) and found short-term positive changes in sugar and sugary beverage intake (Davis et al., 2007a) with associated improvements in insulin secretion (Davis et al., 2007b). However, such a nutrient focus may have the potential to reduce the usefulness of intervention as it does not account for adolescent behaviours described in the clinical practice guidelines above.

2.2.6.1.2 Traffic Light diet

One of the most common dietary interventions is the Traffic Light or Stoplight diet. This was developed and used extensively by Epstein’s research group in 6-12 year old children and has shown some positive long-term changes in BMI in this group (Epstein et al., 1994). It is essentially an energy-controlled diet, with differing amounts of food to come from the red food group (high energy density), yellow
food group (mostly core foods) and green food group (low energy and able to be consumed freely), whilst the pattern of meal spacing during the day is variable (Valoski and Epstein, 1990). The aim of the diet is to provide maximum nutrition without providing excessive energy (Academy of Nutrition and Dietetics, 2006). A number of multicomponent adolescent trials have used the Traffic Light/Stoplight diet with a prescribed energy intake (Reinehr et al., 2010, Epstein et al., 1994, Diaz et al., 2010) or a modified version of the Traffic Light/Stoplight diet (Janicke et al., 2008a, Kalarchian et al., 2009, Jiang et al., 2005, Johnston et al., 2007, Saelens et al., 2002). There is good evidence to support the use of the Traffic Light diet in obesity interventions for 6-12 year olds, however, the effectiveness of this diet has not been evaluated in adolescents (Academy of Nutrition and Dietetics, 2006).

2.2.6.1.3 Dietary prescription

In studies with a prescribed diet plan, the structure and content of meals is usually imposed on the adolescent in the form of specified meals and snacks. A pilot study of 25 obese adolescents evaluated the effect of a structured meal plan versus a non-diet approach (Savoye et al., 2005). In the non-diet approach, adolescents were instructed to choose their own intake of food and beverages, within the healthy guidelines taught during the intervention. The authors found that the adolescents who requested the meal plan intervention had less favourable outcomes at 12 months post-program and returned to baseline measures at 24 months post-program, whilst the non-prescribed diet group sustained positive changes (Savoye et al., 2005). This approach was further evaluated using a randomised controlled trial in a group of 209 American adolescents (Savoye et al., 2007). However, the group receiving the structured diet plan had to be discontinued after 83% of participants randomised to this arm dropped out before six months. One further study has described the use of prescribed meal plans but the effectiveness has not yet been evaluated (Marques et al., 2012). Three other multicomponent adolescent interventions have used only prescribed kilojoule intakes but did not enforce a specific meal plan (Rynders et al., 2012, Karner-Rezek et al., 2013, Jelalian et al., 2010). These studies did not measure dietary intake, so adherence to the kilojoule restriction or the effectiveness of the dietary component on body composition
cannot be evaluated. Thus, the available evidence does not support the efficacy of prescribed dietary plans for use in adolescents, particularly as it remains unclear how the prescribed temporal pattern differs to that of the normal pattern, and whether the changes are sustainable long-term. More information is needed about adolescent patterns of eating to develop more applicable and targeted recommendations. For example, a description of actual junk food consumption patterns would inform specific high consumption periods to target, rather than a blanket strategy to reduce overall junk food consumption.

2.2.6.1.4 Food group-based approach
Dietary interventions using a food group-based approach have not been well described or evaluated. These interventions do not prescribe intakes of nutrients, rules for food consumption or particular eating plans but encourage adolescents to make their own healthy food choices. Gehling et al. (2005) used a typical diet reported in the most recent Australian National Nutrition Survey to develop a simple set of food-based recommendations that were theoretically the most effective in reducing energy intake. This modelling exercise showed that for 6-12 year old children, five key changes to a typical high-fat child intake (swapping to reduced fat milk, reducing intake of cereal and snack foods, replacing juice or soft drink with water, avoiding adding fat to vegetables and choosing lean meat) could reduce energy intake by 10%, fat by 30% and saturated fat by 53% (Gehling et al., 2005). Limitations to this analysis include the now out-dated 1995 data from the National Nutrition Survey used to develop the recommendations and the assumption that the majority of overweight children are consuming high fat, high energy diets. These recommendations were evaluated in a randomised controlled trial of 160 children, using an FFQ to evaluate dietary change. Children were assigned to a child-only physical activity intervention, a parent-only dietary intervention or a combination of the two. There were significant reductions in BMI z-score after 2 years for all groups, although the groups receiving the dietary intervention fared better overall (Collins et al., 2011). Dietary results showed reduced consumption of energy-dense, nutrient-poor snacks (including soft drink, potato crisps and chocolate) sustained at 2 years post-intervention for all
participants, suggesting long-term healthy habits had been developed (Burrows et al., 2011). However, there were no group by time effects for energy intake change, despite the activity-only group not receiving a dietary intervention. Many of the nutrient and food group intakes showed statistically significant improvements over the two years, however, these changes were not compared between the groups. This makes it difficult to evaluate the effectiveness of the dietary intervention, particularly when dietary improvements were also reported in the activity-only group. Whilst this evidence-based framework used a ‘real-life’ diet to create targeted healthy eating recommendations for use in the management of childhood obesity; the applicability to overweight adolescent diets has not been investigated.

The development of other approaches to support healthy eating is not well described in the literature, but reflects clinical practice guidelines. This often includes a focus on improving dietary behaviours (like eating a regular breakfast), improving intake (such as increasing intake of nutrient-dense foods) or a combination of these strategies. A number of other trials have used education regarding basic healthy behaviours with an energy prescription (Lloyd-Richardson et al., 2012, DeBar et al., 2012, Knopfli et al., 2008, Nemet et al., 2006) or without an energy restriction (Shaibi et al., 2012, Lubans et al., 2011, Wengle et al., 2011, Nguyen et al., 2013, Burnet et al., 2011, Park et al., 2007, Steele et al., 2012, Sacher et al., 2010, Weigel et al., 2008, Eliakim et al., 2002, Ball et al., 2011, Burguera et al., 2011, Resnicow et al., 2005, Woolford et al., 2011b, Olvera et al., 2010, Coppins et al., 2011, Savoye et al., 2011, Kong et al., 2013, Panagiotopoulos et al., 2011, Kubicky et al., 2012, Kolsgaard et al., 2011, Saelens et al., 2002, Kitzman-Ulrich et al., 2009, Tsiros et al., 2008, Sarvestani et al., 2009, Bean et al., 2011). Some trials have focussed on developing specific behaviours to support diet change, such as frequent self-monitoring (Saelens et al., 2002, Kitzman-Ulrich et al., 2009, Tsiros et al., 2008, Sarvestani et al., 2009). However, in trials using a food group-based approach, there is often very little justification provided for why the particular approach to dietary intervention has been chosen.
2.2.6.2 Evaluation of dietary interventions

Overall, dietary interventions are not well described in the literature, nor are they comprehensively evaluated. The dietary outcomes from the overweight adolescent trials are not consistently reported, as reviewed in detail in section 2.3. Further, measures of overweight adolescent adherence to dietary interventions are not routinely reported in the literature. In a recent systematic review, Ho et al. (2013) stressed the need for researchers to assess and report participant adherence to the chosen dietary approach to provide evidence for improved design of dietary interventions for overweight adolescents. One of the biggest limitations of measuring participant adherence is selecting appropriate methods to indicate adherence. For example, adhering to key principles (e.g. using olive oil as part of a Mediterranean diet) will provide a different insight as compared to adhering to a daily target (e.g. eating 3 serves of fruit per day). This limitation should be considered in the following review of adherence measures.

2.2.6.2.1 Adherence to dietary interventions

The assessment of adherence to interventions for chronic childhood illness is critical to enhance the understanding of the effectiveness of treatment (Quittner et al., 2000). A generally accepted definition of adherence is “the extent to which a person’s behaviour (in terms of medications, following diets, or executing lifestyle changes) coincides with medical or health advice” (Haynes, 1979). Measuring adherence to dietary treatment is particularly important as it has been shown that the primary reason for poor outcomes following dietary intervention is low levels of adherence to the prescribed diet (Heymsfield et al., 2007). This was shown in a study of adults, in which adherence to four popular diets was measured using food records and self-reported levels of adherence (Dansinger et al., 2005). These measures were converted into a ten point scale of adherence. The authors of this study found no difference in outcomes between the diets, but increased levels of adherence to any of the diets was associated with greater weight loss and better health outcomes. Across all four diets, Dansinger et al. (2005) showed generally low levels of self-reported adherence and concluded that adherence was more important than diet type in achieving positive health outcomes.
2.2.6.2.2 Measuring adherence to guidelines

Adherence is not routinely reported in the adolescent intervention literature, nor is the method for measuring adherence standardised. Many studies of adolescent diet are likely to consider adherence to dietary guidelines, where recommended intakes has been clearly defined. This has been shown in a study of 2813 Slovenian adolescents, who completed FFQs and kept three day weighed food records (Kobe et al., 2012). The authors reported the percentage of the adolescents who adhered to recommendations for food group intakes. For example, only 11% of boys and 10% of girls met the recommendations for vegetables (Kobe et al., 2012). A similar style of reporting based only on FFQs and a short dietary questionnaire was also used in overweight adolescents, to show the percentage adhering to the guidelines for fruit and vegetable intake (Shrewsbury et al., 2011a). However, given that adolescent dietary intake rarely reflects dietary guidelines (Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008), this measurement is not likely to be sensitive to change following an intervention.

2.2.6.2.3 Measuring adherence to diets

Other studies have measured adherence to particular diets, such as the Mediterranean diet (Santomauro et al., 2014, Trichopoulou et al., 2003). In a study of adolescents, Santomauro et al. (2014) used a pre-developed measure of diet quality (Serra-Majem et al., 2004), which in brief comprised 16 yes/no questions regarding dietary habits related to the Mediterranean diet. Scores were assigned to each question with +1 indicating adherence to the Mediterranean diet principles and −1 indicating non-adherence. The authors then developed their own measure of adherence by classifying scores of ≥8 as good adherence, 4–7 as average adherence and <4 as poor adherence (Santomauro et al., 2014). In a similar study done in adults, an FFQ was used to calculate individual intakes of key food groups and nutrients, which was used to assess adherence to the Mediterranean diet (Trichopoulou et al., 2003). Intakes were compared to the median group intake for protective foods (e.g., fruit), risk-associated foods (e.g., meat) and alcohol (Trichopoulou et al., 2003). This comparison was used to develop a score of adherence to the traditional Mediterranean diet, with 0 representing poor
adherence and 9 representing good adherence. These studies measure adherence to a particular pattern of eating using approaches developed to suit the research question. This is useful to potentially identify associations between diet and health risk (Trichopoulou et al., 2003), but have not previously been used to measure change over time.

2.2.6.2.4 Measuring adherence to interventions

Adherence is not routinely measured in interventions, possibly due to a lack of a gold-standard method (Vitolins et al., 2000). The assessment of adherence is also complicated by the nature of the intervention. For example, assessing dietary change is considerably more complicated than assessing dichotomous outcome variables, such as whether a participant took a daily multi-vitamin or not (Modi et al., 2013). In studies, adherence can be assessed as a simple percentage, like a calculation of the number of times the multi-vitamin was taken as a percentage of the number of times it was prescribed (Modi et al., 2013). However, assessing behaviour change with multiple components is more complex. In adolescents, dietary adherence to the DASH diet has been assessed using plasma vitamin C levels as an indicator of fruit and vegetable intake (Saneei et al., 2014). The authors of this study found that plasma vitamin C levels increased during the intervention, and concluded that relatively good dietary compliance had occurred during the intervention (Saneei et al., 2014). Although this biomarker may represent increased intake of fruit and vegetables, the change was not statistically significant and the level of adherence is only an estimate at best. The lack of clear guidelines for what constitutes high or low levels of adherence to dietary interventions makes it difficult to draw conclusions about adherence (Vitolins et al., 2000). In a study of adult women comparing a low fat or low carbohydrate diet, adherence to the prescribed diet was measured using seven day diet records at the conclusion of the study (Foraker et al., 2014). Adherence was based on the key component of each intervention and defined as having an energy intake within 20% of the prescribed energy intake for fats or carbohydrates, depending on whether the participant had been randomised to the low fat or low carbohydrate arm (Foraker et al., 2014). There are no clear guidelines for using ±20% as a measure of adherence, and it
seems of the small number of studies that measure adherence, most choose a
method that seems to fit with their outcome measures.

In a small study of obese adolescents (n=8) following weight loss surgery, Ratcliff et
al. (2014) measured adolescent adherence to recommendations for consuming 3-6
meals/day, having meals ≥20 minutes and not lying down for one hour following
meals. These behaviours were measured with a personal device that required
adolescents to log their daily activities. Adherence was defined as meeting the
recommendation every day (Ratcliff et al., 2014). The authors of this study reported
the level of adherence to each of these recommendations at two time points, but
there was no interpretation of what might be considered to be a good or poor level
of adherence. This was only a pilot study, but the unique approach to measuring
adherence is an important start to fill the gap around lack of adherence measures in
interventions.

To date, there are no reports of adherence to dietary interventions in overweight
adolescent interventions. It is evident that assessing adherence is limited by the lack
of standardised measures and accepted definitions. However, without the detailed
evaluation of these trials and quantification of adherence, it is particularly difficult
to understand the impact of intervention on behaviour or weight change in
overweight adolescents.

*Identified gap: There is a significant gap in the literature regarding the
details of dietary components of multicomponent interventions, and lack
of evidence for the implementation and evaluation of these.*

### 2.2.7 Recruitment for interventions

A strong evidence base is lacking to support the development of effective
recruitment strategies for intervention trials (Foster et al., 2011). This may explain
why recruitment for research trials is challenging and often exceeds the time
allocated (Warren et al., 2007). In a review of three Australian weight management
interventions for children, Warren et al. (2007) reported that recruitment took
longer than planned in all of the studies. The authors recommended an allowance
of sufficient time and staff resources to allow for recruitment of sufficient
participants in a timely manner (Warren et al., 2007). The recruitment for adolescents for intervention trials has been identified as a particularly difficult task (Steinbeck et al., 2009). The authors suggest that a lack of concern about health outcomes may explain why adolescents are resistant to engaging in health-related interventions (Steinbeck et al., 2009), yet concern about health is a primary motivator for parents (Grow et al., 2013). Thus, parents play an important role in encouraging enrolment in health-related interventions (Steinbeck et al., 2009). A previous qualitative study was undertaken with parents (n=16) and adolescents (n=65) who were potential participants of a physical activity intervention. The focus groups and interviews highlighted some of the factors impacting on recruitment of adolescents. One of the main barriers identified was the potential for the timing of the intervention to clash with other extra-curricular activities. To promote the intervention, the participants highlighted the importance of word of mouth referrals and the need for the program to be perceived as fun (Jago et al., 2011). Other qualitative studies have concluded that it is impossible to meet the needs of all potential participants (Grow et al., 2013).

In overweight adolescent interventions, most studies have provided a short description of the recruitment strategies used, but not made recommendations for future interventions. Some obesity trials utilised existing tertiary or outpatient programs and had an existing pool of overweight and obese adolescents from which to recruit to participate in a randomised trial (Savoye et al., 2007, Eliakim et al., 2002). Other studies reported recruiting participants via school and community advertising, whilst many also engaged local doctors or paediatricians as a source of referral, however the usefulness of these strategies are often not described. Two studies that have explored these strategies in significant detail are reviewed below (Nguyen et al., 2012a, Rice et al., 2008).

Nguyen et al. (2012a) reported the effectiveness of different recruitment strategies used in an Australian study aiming to recruit 168 overweight adolescents aged 13-16 years. The authors described articles in school newsletters and community newspapers as the most cost-effective means of recruiting overweight adolescents. These strategies resulted in almost 60% of enquiries; however the authors stated
that this would be insufficient to yield enough participants. This is particularly pertinent because only one third of the families enquiring actually enrolled in the program, highlighting the large number of enquiries needed to enrol the desired number of participants. The other recommended strategies for recruitment of overweight adolescents included involving a Public Relations department in the recruitment efforts and potentially targeting peer-based recruitment.

In an American intervention for overweight youth aged 7-17 years, Rice et al. (2008) assessed the success of the three recruitment strategies employed in the study. These strategies were 1) education and promotion to doctors, 2) school-based BMI screenings and 3) large scale public marketing including print, web and television advertising. The results showed that local physicians were responsible for almost half of all enquiries (Rice et al., 2008). However, only 10 percent of the final registrations came from families who had enquired following physician referral. This might suggest that although families may be interested, there are a number of possible barriers that prevent them from taking the next step to register for the program. Word-of-mouth was highlighted as a successful recruitment strategy resulting in 13 percent of registrations. In this study, letters sent home from school and program flyers sent to houses were particularly ineffective, and resulted in only one registration. In regards to the most effective methods of recruitment for overweight adolescents, these two studies draw conflicting conclusions (Nguyen et al., 2012a, Rice et al., 2008). This may reflect country specific differences and highlights the need for further evidence to support the development of targeted and effective recruitment strategies.

### 2.2.8 Retention in interventions

Few studies have investigated the best ways to maximise adolescent and parent engagement and retention during the intervention phase. This is of particular concern given dropout rates are relatively high in healthy lifestyle programs as compared to other health-related interventions for adolescents (Skelton and Beech, 2011). In a review of the literature, attrition rates were shown to range between 27% and 73% of participants in child and adolescent weight-related interventions (Skelton and Beech, 2011). Across a number of studies in this review, 25-50% of
participants dropped out after the initial appointment, highlighting the need for effective strategies to encourage retention. The authors of this review emphasised the importance of further research to understand why families drop out from obesity treatment programs and how this can be attenuated.

In a study of clinicians working in adolescent weight management interventions, qualitative interviews were conducted with 29 obesity clinicians from primary, community and tertiary care programs (Skelton et al., 2012). Clinicians identified a number of issues that they believed would influence family engagement in weight-related interventions (Skelton et al., 2012). These often related to family factors or strategies to increase adherence. Clinicians described barriers experienced by families such as difficulty with transportation, financial stress, other commitments and low levels of motivation. Clinicians also identified a number of strategies or enablers to maximise participation including offering entertaining activities and incentives (Skelton et al., 2012). This study provides a detailed report of clinician perceptions; however, this may not be representative of the actual barriers and enablers facing adolescents and parents.

Perceived barriers to participation have been previously reported in a group of Australian parents (n=56) and adolescents (n=56) after involvement in a 14 week individual family intervention (i.e. not a group program) (Brennan et al., 2012). Both adolescents and parents who completed and those who did not complete the program were involved in telephone-based questionnaires to assess barriers to participating. For adolescents who did not complete the whole program (n=32), these included a lack of time, school commitments, perceived excessive monitoring and travel difficulties. For parents who did not complete the program, these barriers included travel difficulties, lack of interest and lack of time (Brennan et al., 2012). Although all participants experienced some barriers to participating, the families who dropped out of the intervention reported a greater number of perceived barriers. Whilst this study presents a detailed summary of the barriers experienced by families during interventions, it does not assess the factors that helped families to stay involved with the intervention. Future exploration of the
possible enablers to maximise participation will be important to guide the development of future interventions.

Identified gap: There is a lack of strong evidence to guide effective intervention delivery for overweight and obese adolescents

2.2.9 Maintenance following intervention

The period following intervention is a critical time for the consolidation of healthy behaviours and maintenance of weight loss (Baum et al., 1991, Perri et al., 1984). Changes occurring during this maintenance period are often not well documented in the literature, nor are there strong levels of evidence about how to best achieve sustained behaviour change or weight maintenance (Butryn et al., 2010, Fjeldsoe et al., 2011). In adolescents, a review of the most recent diet, activity and diet plus activity interventions suggested that participants were likely to experience partial weight regain during the maintenance period, along with the loss of metabolic improvements seen during the active intervention phase (Ho et al., 2013). Further to this, data regarding the tracking of participant weight loss or gain is often biased by the high likelihood of selective attrition in the long-term, with those who have not been successful in their attempts at sustaining weight loss more likely to withdraw (Douketis et al., 2005). This limits the conclusions that can be drawn from any long-term data for sustained behaviour change or weight maintenance in adolescents.

The evidence base is limited as to how adolescents most successfully maintain behaviour change or weight loss following short-term interventions. Lieberman (2009) compared the experiences of adolescents who had been successful in maintaining a weight reduction with those who had gained weight following initial weight loss. In this group of 22 adolescents, successful weight losers were more likely to participate in vigorous daily exercise and have family members who supported behaviour change. These adolescents were also likely to have experienced a ‘transformative event’, which changed their perception regarding
their weight and motivated them to change their behaviour. Interestingly, both successful weight losers and weight re-gainers reported similarly poor diets post-intervention, possibly indicating that diet was not responsible for changes in weight or that there were flaws in dietary assessment (Lieberman et al., 2009). Frohlich et al. (2011) also showed that family-related factors such as maternal levels of depression were able to predict maintenance of weight loss in 111 children and adolescents and thus family functioning may be an important area for maintenance.

In adults, data from the National Weight Control Registry in the USA suggested that a combination of diet and activity changes was essential for weight maintenance after initial weight loss (Wing and Phelan, 2005). Successful maintainers of weight loss reported eating a low fat and low energy diet, eating breakfast every day, maintaining consistent eating patterns, engaging in high levels of physical activity, frequently self-monitoring and acting quickly to manage relapses (Wing and Phelan, 2005). This research also showed that long-term weight maintenance was also associated with higher levels of emotional regulation and experiencing a ‘transformative event’ similar to that described earlier.

2.2.9.1 Maintenance support

Despite a general understanding of how individuals maintain weight loss, there is little evidence about how to best offer clinical support for behaviour change during the maintenance period. The majority of the research in this area is observational, and comes from adult studies. Reviews of adult trials have identified maintenance of meaningful contact between clinicians and participants as a common strategy used during this time (Jeffery et al., 2000, Turk et al., 2009). Contact can continue through face-to-face contact (i.e. booster sessions) or personalised contact via phone or email, although all these methods can be resource intensive. Current evidence suggests that self-directed maintenance, such as a work book given to participants to work through in their own time, appears to be less successful than personalised contact in achieving weight maintenance following a weight loss intervention (Svetkey et al., 2008, Sherwood et al., 2013). For example, a large randomised trial in overweight American adults showed a difference in weight outcomes based on the maintenance program received. The group receiving
personal contact for the 30 month maintenance period regained less weight than those receiving a self-directed or interactive technology maintenance program. Despite these positive results, energy intake (as measured by a 127 item FFQ) and energy expenditure did not differ between the three groups (Svetkey et al., 2008). It remains unclear what was responsible for the lower level of weight regain. The authors of this study did not assess the dietary results for any level of misreporting nor account for a possible lack of sensitivity with the FFQ, thus the dietary results may not accurately represent true intake and the role of diet in weight loss maintenance remains unclear.

2.2.9.2 Maintenance in overweight adolescent intervention studies

Few studies in overweight adolescents have compared different approaches to supporting weight maintenance following lifestyle intervention. Davis et al. (2012) conducted a four month lifestyle intervention followed by an eight month maintenance intervention in a group of 53 Latino and African-American adolescents. Participants were randomised to either a group receiving monthly booster sessions and phone support or a group receiving monthly newsletters. Participants from the booster group were the only ones who had direct contact with program staff, although both interventions included similar content based on the program goals. There was no difference in outcomes between groups observed at eight months post-intervention (Davis et al., 2012), suggesting that less frequent and written contact may be sufficient to achieve the same results as personal contact. During the maintenance period, both groups experienced a decline in leg strength but showed improvements in cholesterol levels and insulin sensitivity. Neither group showed any further changes to dietary intake during the maintenance period, although changes were maintained from post-intervention levels.

In an Australian study of 151 adolescents, Kornman et al. (2010) described the implementation of a maintenance program incorporating electronic contact via phone coaching and text messaging or email (Nguyen et al., 2013). This electronic contact served as a maintenance program for half of the cohort following the seven
week weight loss intervention and the delivery is discussed below in section 2.2.2.3.4 relating to the use of text messaging to support behaviour change. The group receiving the additional therapeutic contact did not show any improvements in anthropometric or behavioural outcomes at 12 or 24 months following baseline (Nguyen et al., 2012b, Nguyen et al., 2013), suggesting that this intervention at this dose was not any more effective than no contact.

Following a 16 week intervention for 188 obese adolescents, Lloyd-Richardson et al. (2012) engaged participants in four maintenance group sessions held every two weeks. Maintenance contact was then reduced to quarterly activities to maintain adolescent links with the research staff. These activities were mainly enjoyable opportunities for social contact, such as miniature golf, and did not contain educational content. For the 89 adolescents who completed the 24 month evaluation, reductions in BMI z-scores were maintained between post-intervention and 24 months. However, improvements in some psychological measures following intervention were only maintained until 12 months. In addition, no measures of dietary intake were collected. Without a control group, it is not clear whether the maintenance strategies used in this study were useful at supporting behaviour change. Weight change was maintained, but this cannot be directly attributed to the strategies used.

Tsiros et al. (2008) showed that a ten week cognitive behavioural therapy program followed by five telephone calls over a further ten week maintenance period was successful in improving the diet and body composition of a small group (n=25) of overweight adolescents, as compared to a control group (n=22). However, direct conclusions regarding the maintenance period are limited because only ten adolescents completed the last ten weeks due to drop outs and resource constraints. The authors did not compare outcome changes (diet or body composition) between the intervention and maintenance periods in the intervention group, so it is difficult to assess the effectiveness of this maintenance program.
In a pilot study of 20 obese adolescents aged 11-18 years Deforche et al. (2005) evaluated a five month maintenance treatment program. All participants had received the ten-month obesity treatment before half of the participants were assigned to the maintenance control group and half were assigned to the experimental group. The experimental group received the maintenance program, although the start was delayed for six weeks after conclusion of the intervention due to summer holidays. The maintenance program included weekly contact by mail or phone for the first 15 weeks, then a further two times in the remaining six weeks. Participants were asked to self-monitor their physical activities and sedentary behaviour and submit this weekly. Participants were encouraged to set goals and could achieve points or incentives for being involved in physical activity, however there was no focus on dietary intake or behaviours in this trial. After five months there was a significant difference between the weight gain trajectories for the two groups, despite both groups gaining weight during the summer holidays. Adjusted BMI (actual BMI/ideal BMI) continued to increase in the control group and slowed in the intervention group. Further, physical activity increased in the experimental group but decreased in the control group, with a significant group by time effect. The maintenance component of this pilot study appeared to have some impact on weight and behaviour change following intervention, but the results are limited by the small sample size and the impact of the six week break in treatment.

In a study by Savoye et al. (2011), a group of 209 children and adolescents (8-16 years) participated in a 12 month weight intervention comprising six months of intensive treatment and six months of reduced contact. During the intensive intervention, participants received twice-weekly sessions, which was followed by six months of sessions occurring once every two weeks. Although the authors included the maintenance period as part of the intervention in the analysis, the tapering of contact is often a key feature of maintenance periods. Assessments were completed at six months following baseline (immediately following intensive intervention) and again at 12 months (six months following intensive intervention), making it possible to compare outcomes from these two periods. Results from this study showed that improvements in BMI, body weight and body composition at six
months post-baseline were maintained for the following six months during the tapering ‘maintenance’ period. Further, the control group continued to gain weight over the 12 month period, resulting in significant differences between the two groups at both time points. There were no dietary measures used in this study. Participants all received the same maintenance program following intervention so the lack of a control group prohibits the evaluation of the effectiveness of such a program, but provides positive support for ongoing contact to support weight maintenance.

In younger children aged 7-12 years, Wilfley et al. (2007) showed that two different maintenance approaches, namely a focus on maintenance strategies and a focus on the creation of supportive environments, were more effective at supporting long-term weight loss than no treatment. In this randomised controlled trial the maintenance programs were implemented over four months, and weight loss results remained significant at both one year and two years after the start of the initial intervention. The only measure of diet in this study was perceived self-efficacy in adhering to a low-fat diet, and this was maintained until one year in both experimental groups but not in the control group. Further, only the supportive environment group maintained improvements in this measure of self-efficacy at two years from baseline. These findings are difficult to extrapolate to adolescents, particularly because parents were the main focus for facilitating the creation of supportive environments for their children in one of the groups.

**Identified gap:** There is a lack of evidence about how to best support overweight adolescents in the maintenance period following intervention

### 2.2.9.3 Text messaging as a maintenance support for adolescents

There is little data around how to best support the maintenance of healthy behaviour change in adolescents after completing a multidisciplinary weight management program, indicating a need to explore innovative and cost-effective ways of enhancing obesity treatment in this group (Pratt et al., 2008). Telephone support has had positive effects with parents of overweight children (Estabrooks et al., 2009) and overweight adolescents (Tsiros et al., 2008) (as described above),
however, this is often resource intensive and relies on participants being available at the same time as program staff (Estabrooks et al., 2009). In the adolescent study by Tsiros et al. (2008), only a small number of adolescents in the intervention group received the telephone support due to resource constraints. Email and online contact is also generally well accepted as having potential for enhancing adolescent obesity treatment (Lau et al., 2011) but relies on regular access to a computer and internet and is a more delayed form of contact. Text messaging, also known as short messaging service or SMS, offers real-time contact whilst potentially being personal and easy to use (Franklin et al., 2003, Fjeldsoe et al., 2009, de Niet et al., 2012a). The nature of text messaging can reduce the burden on researchers and participants by providing a means of communication that is accessible at whatever time suits each party (Fjeldsoe et al., 2009). Text messaging has been used in healthcare as a reminder service (Franklin et al., 2006) but the use of text messaging as a form of intervention has been less widely utilised and is still being evaluated among different groups (Siopis et al., 2014).

2.2.9.3.1 Text message design for adolescents

There is little information regarding the best way to structure the text messages to send to adolescents (Woolford et al., 2011a). Several studies that considered adolescent behaviour change have described the wording and timing of messages used in the intervention (Kornman et al., 2010, de Niet et al., 2012a, Franklin et al., 2003, Sirriyeh et al., 2010), whilst only two studies have described the testing of text message format with adolescents before an intervention commenced (Woolford et al., 2011a, Hingle et al., 2013). The findings from all these studies suggest that a positive tone is important, as well as the use of encouraging words and phrases (de Niet et al., 2012a, Woolford et al., 2011a). Most adolescents seemed to like emoticons such as smiley faces in the text messages (Franklin et al., 2003, Woolford et al., 2011a), although they recommended that researchers avoid text slang and abbreviations, and instead use natural language (Woolford et al., 2011a). Tailoring of messages has long been identified as an important part of any health intervention (Mauriello et al., 2010) and most text messaging studies have tailored messages by using first names and references to personal goals or past text
contact (Fjeldsoe et al., 2009, de Niet et al., 2012a, Woolford et al., 2011a, Kornman et al., 2010, Woolford et al., 2010, Shapiro et al., 2008, Franklin et al., 2006). Using the word ‘you’ in a message or including facts specific to teens were viewed favourably by adolescents (Hingle et al., 2013). For example, ‘Eating foods high in protein helps you feel full. Want to see examples of foods that contain protein?’ It is recommended that messages be constructed to sound like they had come from the research team, even when they were automated messages (Kornman et al., 2010, Woolford et al., 2011a) and that a maximum of two reflective questions are included in any single message (Woolford et al., 2011a).

### 2.2.9.3.2 Timing of text messages

In regard to timing, five studies among adolescents sent at least daily messages (Shapiro et al., 2008, Woolford et al., 2010, Franklin et al., 2006, Hingle et al., 2013, Sirriyeh et al., 2010), one study requested participants to send weekly messages to the research team (de Niet et al., 2012a) and one sent monthly messages from the research team (Kornman et al., 2010). In two studies, adolescents reported that daily text contact was liked by participants (Franklin et al., 2006) or considered to be sufficient (Woolford et al., 2010). These attitudes were not compared to behaviour change and no other studies assessed adolescents’ perception of text message frequency. It remains unclear as to how important dose is in relation to behaviour change, or what the optimal dose for contact is for adolescents.

### 2.2.9.3.3 Content of text messages

Overweight adolescents have indicated a strong preference for directive messages, which seems to contradict the desire for autonomy and the key approach to most adolescent programs (Woolford et al., 2011a). Woolford et al. (2011a) suggest that adolescents often avoid the psychological work associated with reflection and note that text messages may not allow sufficient exploration of this. They recommend wording messages to give some direction within an autonomous framework, whilst avoiding coercion. Providing recipes and testimonials from other teenagers (e.g., Other teens have found it helpful to…) has been suggested as a way to do this (Woolford et al., 2011a). Sirriyeh et al. (2010) found that SMS based on affective beliefs (enjoyable/unenjoyable) contributed to more positive behaviour change.
than instrumental beliefs (beneficial/harmful), hence they recommend emphasising the enjoyment and social nature of healthy behaviours.

Many researchers have divided texts into categories to structure the delivery of messages to participants. This variety is important because in a study where adolescents received daily texts, 20% indicated they got bored receiving the same text message (Franklin et al., 2006). Woolford et al. (2010) noted that researchers need to be creative with the phrasing they use in text messages to minimise the repetitive nature of the contact. The common themes across the adolescent text messaging studies included using core messages already taught during the intervention, providing general support and encouragement, reminding participants about their personal goals and reminding participants of skills they had to manage their own setbacks (Franklin et al., 2003, de Niet et al., 2012a, Woolford et al., 2011a, Kornman et al., 2010).

2.2.9.3.4 Use of text messages with adolescents

To date, there has been limited evaluation of SMS as a means of enhancing obesity treatment with adolescents and a lack of research into the use of a combination of communication methods with this group. Most studies using text messages have focussed on adolescents of varying weight statuses, or used the text messaging to support the intensive intervention. Only one study has investigated the use of text messaging with overweight adolescents following intervention. This section reviews the key trials in the area, and notes a number of difficulties associated with extrapolating these findings to overweight adolescents in the maintenance phase.

The one study that has evaluated the use of text messaging during the maintenance period for overweight adolescents occurred in Australia (Shrewsbury et al., 2010). Following the intensive intervention phase of the Loozit program, adolescents aged 12-16 years were randomised to receive either additional therapeutic contact in the form of phone coaching and text/ email or no further contact (Nguyen et al., 2013). The additional contact occurred fortnightly and consisted of 14 phone calls and 32 electronic messages (email and text messages) over 21 months, with an average of one text message sent per month. Adolescents reported that the e-contact was
‘somewhat helpful’ (Kornman et al., 2010). However, one and two year outcomes showed no effect of additional therapeutic contact, with the authors concluding that the dose may not have been frequent enough (Nguyen et al., 2013). The authors recommended future use to include at least weekly contact.

A second study investigated text messaging with overweight adolescents, however the messages were delivered during the intensive phase of a 90 day weight management program, rather than during the maintenance phase (Woolford et al., 2010). Adolescents aged 12-18 years received daily text messages designed to increase adherence to the program. The messages covered five topics regarding breakfast consumption, fruit and vegetable consumption, reducing consumption of sweetened beverages, reducing consumption of fast food and reducing screen time (Woolford et al., 2010). The authors concluded that sending text messages from the research team was both feasible for researchers and acceptable for adolescents in the program. These results are limited by a small sample of only 20 adolescents and findings may not be generalizable to the maintenance period. For example, adolescent perceptions of text messaging during the maintenance intervention phase may be impacted by factors such as waning motivation levels and loss of face-to-face contact with program staff and other adolescents. The authors of this study are reportedly currently implementing a randomised controlled trial to assess the effectiveness of an SMS adjunct in promoting behaviour change in a larger cohort.

Three other studies using text messaging with adolescents are reviewed below. While these trials do not focus on overweight adolescents, they do encourage healthy behaviour change in adolescents and may provide some useful insights.

Hingle et al. (2013) piloted a text messaging program in a group of 32 adolescents from four youth groups. The text messages were developed with input from adolescents and sent daily to adolescents over an eight week period. The messages consisted of fun facts, quizzes and recipes and small group interviews were used to understand adolescent responses to these texts. The findings from this pilot study suggested that the health promoting text messages were acceptable to adolescents,
although the impact on behaviours was not measured (Hingle et al., 2013). Additionally, the adolescents in this pilot study were of varying weight statuses, so findings are not generalizable to overweight adolescents. The text messaging also occurred as a stand-alone intervention, and thus the findings cannot be extrapolated to a group of adolescents who have already completed a health-related intervention.

In another study of text messaging for adolescents, a group of 120 British adolescents aged 16-19 years were sent daily text messages to encourage behaviour change (Sirriyeh et al., 2010). These text messages were delivered over a two-week period and were designed to promote increased engagement in physical activity. Adolescents in the experimental arm of the study reported increased levels of physical activity during the intervention; however this was only statistically significant in the subgroup of adolescents who were considered ‘inactive’ at baseline. These results are limited by a very short intervention and follow-up period, thus the results are unlikely to reflect adolescent perceptions after receiving the text messages for a much longer period of time. This study did not report the adolescents’ satisfaction with receiving daily text messages, so the preferred or acceptable dose of text messaging remains unclear. Further, the use of a self-reported questionnaire for the assessment of physical activity may have lacked the precision needed to identify short-term changes in this study (Sirriyeh et al., 2010).

A randomised control trial by Franklin et al. (2006) used tailored text messages to remind adolescents with diabetes about the goals they had set in clinic and encourage them to monitor their progress towards these goals. Improved glycaemic control was observed in the group receiving intensive therapy with the SMS component, but not in the group receiving standard therapy with or without the SMS component. Participants receiving the texts showed a significant increase in self-efficacy and self-reported adherence and 81% felt that their diabetic self-management had improved with the text message support and 90% wanted to keep receiving the once or twice daily messages at the end of the trial. This study found that adolescents didn’t mind receiving daily messages, but because the intervention
occurred during active treatment, it is impossible to determine how this might be perceived during a maintenance period.

### 2.2.9.3.5 Summary of the use of text messaging with adolescents

There remain a number of gaps in the evidence base around the use of text messaging to support overweight adolescents following lifestyle interventions. A key issue is the lack of trials that have used text messaging during the maintenance period, as opposed to during the active intervention period. Further, there is only limited literature around the structure of text messaging support (Kornman et al., 2010, de Niet et al., 2012a, Franklin et al., 2003, Woolford et al., 2011a) and within this, only Woolford et al. have directly evaluated the content and wording of texts with obese adolescents (Woolford et al., 2011a). Reviews of the literature in this area also identify the lack of a strong theoretical foundation in much of the research (Fjeldsoe et al., 2009, Militello et al., 2012). There is a clear need for future studies to report on their process measures during intervention and maintenance, to inform others about the best way to structure text messages and how to effectively utilise this form of communication with adolescents (Fjeldsoe et al., 2009, de Niet et al., 2012a, Woolford et al., 2011a, Kornman et al., 2010).

### 2.2.10 Summary of key intervention characteristics in overweight adolescent interventions

There are a variety of interventions for overweight adolescents described in the literature and each has unique characteristics. It appears that there is consistent evidence to support the efficacy of a multicomponent intervention, including a dietary component, to account for the multi-factorial nature of obesity development (Ho et al., 2012). In addition, there seem to be some factors regarding the intervention design that can be tailored to suit the target group. For example, the theory base for intervention or the setting for program delivery can be chosen based on the needs of the group. However, there are limited detailed descriptions of dietary interventions or maintenance programs to support adolescents to make behaviour change and a lack of consensus about whether to target behaviours or weight. This is further complicated by inadequate evaluation of dietary
interventions, limiting the understanding of how diet change might impact on weight change.

### 2.3 Effectiveness of multicomponent interventions with a dietary component

Exploration of change or lack of change in outcome measures following overweight adolescent intervention is critical to understand the effectiveness of intervention. In addition, this exploration can highlight areas for potential future interventions to target. This section of the literature review considers the effectiveness of multicomponent interventions with a dietary component designed for overweight adolescents. While evidence from younger children and adults may also provide information for use in interventions with overweight and obese adolescents, it is beyond the scope of this review.

There were 33 trials identified which met the following criteria. The intervention had to be designed as a treatment for adolescent obesity, include a dietary component, have a duration of at least seven weeks and have some form of pre- and post-intervention outcome assessment. Sixteen trials were completed in the USA (see table 2.3 for further details on each trial). There were four trials involving only females, eight trials were delivered in a hospital setting and nine had at least some component delivered in a community setting (e.g., the physical activity component). Seventeen trials were focussed exclusively on adolescents 12 years and older, while the remaining sixteen trials included both adolescents and participants 11 years and younger. The review of effectiveness of these latter trials will only report on adolescent (≥12 years) outcomes, however, the program may not have been designed specifically for an adolescent audience.

Reporting in adolescent overweight/obesity trials was not standardised. There are a number of ways authors have reported post-intervention findings including: time (months or weeks) following baseline (regardless of intervention length), time following complete conclusion of the intervention or time during the maintenance period where some type of intervention is still occurring. For this thesis, the author
has synthesised the results and used the same wording for all trials for clarity. Thus, results are reported as post-intervention for any data immediately following the intensive intervention, with follow up results reported in the number of months following conclusion of the intensive intervention.

The following sections relate to anthropometric and dietary changes immediately post intervention, between post-intervention and 12 months post-intervention (short-term), and beyond 12 months post-intervention (long-term). All of the trials reported immediate changes in anthropometric outcomes, but only 15 reported immediate diet changes (see table 2.3). Between post-intervention and 12 months post-intervention, only 11 trials reported anthropometric outcomes, with just four of these reporting dietary outcomes. After 12 months post-intervention there were five trials reporting anthropometric outcomes and only two trials reporting dietary outcomes (see table 2.3).
Table 2.3 Comparison of the 33 multicomponent trials identified for overweight adolescents incorporating a dietary intervention.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample</th>
<th>Setting</th>
<th>n (baseline)</th>
<th>Age (years)</th>
<th>Intensive Program Duration</th>
<th>Immediate outcomes</th>
<th>Short-term outcomes</th>
<th>Long-term outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball et al.(2011)</td>
<td>Canadian</td>
<td>Weight management clinic</td>
<td>46</td>
<td>13-17</td>
<td>20 weeks</td>
<td>X</td>
<td>4 day food</td>
<td></td>
</tr>
<tr>
<td>Bean et al.(2011)</td>
<td>Ethnically diverse, American</td>
<td>University, weight management clinic</td>
<td>67</td>
<td>12-15</td>
<td>6 months</td>
<td>X</td>
<td>24-hour dietary recall</td>
<td></td>
</tr>
<tr>
<td>Burguera et al.(2011)</td>
<td>Spanish</td>
<td>School- after school hours</td>
<td>56</td>
<td>11-14</td>
<td>6 months</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coppins et al.(2011)</td>
<td>English</td>
<td>School- after school hours</td>
<td>65</td>
<td>6-14</td>
<td>1 year</td>
<td>X</td>
<td>7 day food diary</td>
<td>X</td>
</tr>
<tr>
<td>Davis et al.(2009a)</td>
<td>Latino, American</td>
<td>Intervention laboratory</td>
<td>54</td>
<td>14-18</td>
<td>16 weeks</td>
<td>X</td>
<td>3 day food record</td>
<td>X</td>
</tr>
<tr>
<td>Davis et al.(2012)</td>
<td>American, female</td>
<td>Primary care</td>
<td>208</td>
<td>12-17</td>
<td>5 months</td>
<td>X</td>
<td>24-hour dietary recall</td>
<td>X</td>
</tr>
<tr>
<td>Diaz et al.(2010)</td>
<td>Mexican children and</td>
<td>Primary care</td>
<td>76</td>
<td>9-17</td>
<td>12 weeks</td>
<td>X</td>
<td></td>
<td>X</td>
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<tr>
<td>Study</td>
<td>Country</td>
<td>Setting</td>
<td>Sample Size</td>
<td>Duration</td>
<td>Follow-up</td>
<td>FFQ</td>
<td>Image</td>
<td>Food Record</td>
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<td>Eliakim et al. (2002)</td>
<td>Israeli</td>
<td>Child health and sport centre at a university</td>
<td>177</td>
<td>6-16</td>
<td>3 months</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Janicke (2008a)</td>
<td>Rural, American</td>
<td>Community sites</td>
<td>71</td>
<td>8-14</td>
<td>8 weeks</td>
<td>X</td>
<td>131 item FFQ</td>
<td>X</td>
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<td>Johnston et al. (2007)</td>
<td>Mexican</td>
<td>School</td>
<td>71</td>
<td>10-14</td>
<td>12 weeks</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Karner-Rezek et al. (2013)</td>
<td>Swiss</td>
<td>Hospital, inpatient</td>
<td>28</td>
<td>12-17</td>
<td>8 weeks</td>
<td>X</td>
<td>3 day food record</td>
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<td>Kitzman-Ulrich et al. (2009)</td>
<td>American, female</td>
<td>Not described</td>
<td>42</td>
<td>12-15</td>
<td>16 weeks</td>
<td>X</td>
<td>24-hour recall</td>
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<td>Hospital, inpatient</td>
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<td>12-15</td>
<td>8 weeks</td>
<td>X</td>
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<td>Norwegian</td>
<td>Hospital and public health nurse office</td>
<td>307</td>
<td>7-17</td>
<td>1 year</td>
<td>X</td>
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<td>American</td>
<td>School</td>
<td>51</td>
<td>13-15</td>
<td>6 months</td>
<td>X</td>
<td>131 item FFQ</td>
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<tr>
<td>Kubicky et al. (2012)</td>
<td>American, Hospital, individual outpatient appointments</td>
<td>61</td>
<td>4-18</td>
<td>47 months*</td>
<td>X</td>
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<tr>
<td>Jelalian et al. (2010)</td>
<td>American</td>
<td>Weight control centre, with some community activities</td>
<td>118</td>
<td>13-16</td>
<td>16 weeks</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Study</td>
<td>Location</td>
<td>Setting</td>
<td>Sample Size</td>
<td>Duration</td>
<td>Methodology</td>
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<td>Israeli</td>
<td>Health centre</td>
<td>24</td>
<td>6-16</td>
<td>3 months</td>
<td></td>
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<td>Nemet et al. (2006)</td>
<td>Canadian, hospital</td>
<td>Hospital</td>
<td>119</td>
<td>6-17</td>
<td>10 weeks</td>
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<td>Panagiotopoulou et al. (2011)</td>
<td>Korean, female</td>
<td>Not described</td>
<td>44</td>
<td>13-15</td>
<td>12 weeks, 3 day diet recall</td>
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<td>Park et al. (2007)</td>
<td>African American, female</td>
<td>Church</td>
<td>123</td>
<td>12-16</td>
<td>6 months</td>
<td></td>
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<td>Resnicow et al. (2005)</td>
<td>American</td>
<td>Clinic and YMCA</td>
<td>16</td>
<td>10-17</td>
<td>6 months</td>
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<td>Saelens et al. (2002)</td>
<td>American</td>
<td>Primary care and telephone contact</td>
<td>44</td>
<td>12-16</td>
<td>4 months, 2 day diet recall</td>
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<td>Sarvestani et al. (2009)</td>
<td>Iranian</td>
<td>Not described</td>
<td>60</td>
<td>11-15</td>
<td>6 months, Dutch Eating Behaviour Questionnaire</td>
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<tr>
<td>Savoye et al. (2007)</td>
<td>American</td>
<td>Obesity clinic and school sites (after hours)</td>
<td>209</td>
<td>8-16</td>
<td>6 months</td>
<td></td>
<td></td>
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<tr>
<td>Shaibi et al. (2012)</td>
<td>Latino</td>
<td>YMCA community centre</td>
<td>15</td>
<td>14-16</td>
<td>12 weeks, Brief dietary assessment tool</td>
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<td>Shrewsbury et al. (2009)</td>
<td>Australian</td>
<td>Community health centres</td>
<td>151</td>
<td>13-16</td>
<td>7 weeks, 15 item FFQ</td>
<td></td>
<td></td>
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<tr>
<td>Study</td>
<td>Country</td>
<td>Setting</td>
<td>Sample Size</td>
<td>Follow-up</td>
<td>Duration</td>
<td>Interventions</td>
<td>Outcome Measure</td>
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<tr>
<td>Nguyen et al. (2013)</td>
<td>American</td>
<td>Outpatient clinic</td>
<td>93</td>
<td>7-17</td>
<td>10 weeks</td>
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<td>Steele et al. (2012)</td>
<td>Australian</td>
<td>Research centre</td>
<td>47</td>
<td>12-18</td>
<td>10 weeks</td>
<td>X 74 item FFQ</td>
<td>X</td>
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<tr>
<td>Tsiros et al. (2008)</td>
<td>Australian</td>
<td>Research centre</td>
<td>47</td>
<td>12-18</td>
<td>10 weeks</td>
<td>X 74 item FFQ</td>
<td>X</td>
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<tr>
<td>Weigel et al. (2008)</td>
<td>German</td>
<td>University hospital</td>
<td>73</td>
<td>7-15</td>
<td>12 months</td>
<td>X</td>
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<td>Wengle et al. (2011)</td>
<td>Canadian</td>
<td>Not described</td>
<td>38</td>
<td>12-16</td>
<td>6 months</td>
<td>X 4 day food record and FFQ</td>
<td></td>
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</tr>
<tr>
<td>Woolford et al. (2011b)</td>
<td>American,</td>
<td>Hospital</td>
<td>67</td>
<td>12-18</td>
<td>24 weeks</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Low intensity- mean of 3 appointments per year*
2.3.1 Immediate anthropometric outcomes (post-intervention)

Immediate post-intervention measures were collected in all but one study (Diaz et al., 2010), although this study collected measures at three months and nine months following intervention. Of the identified interventions for overweight adolescents, primary outcome measures of adiposity were collected in all trials. A large proportion of studies showed changes in adiposity measures compared to baseline measures and the remaining trials reported differences between intervention and control groups over time. The reporting structure differed between trials, with some reporting further anthropometric and metabolic outcomes. These have been included in the review if any outcome was reported, regardless of whether there were changes or not.

2.3.1.1 BMI z-scores/BMI (post-intervention)

Measures of BMI z-scores or BMI were most commonly used to track changes in adiposity. Three trials reported statistically significant reductions at the end of the intensive intervention period in both BMI z-score and BMI measures (Bean et al., 2011, Shrewsbury et al., 2011a, Diaz et al., 2010), while six reported reductions in BMI z-scores ranging between 3-9% (Shaibi et al., 2012, Weigel et al., 2008, Kolsgaard et al., 2011, Lloyd-Richardson et al., 2012, Panagiotopoulos et al., 2011, Kubicky et al., 2012). Five studies reported a reduction of between 3-10% of BMI (Woolford et al., 2011b, Jiang et al., 2005, Eliakim et al., 2002, Coppins et al., 2011, Rynders et al., 2012). Five trials found no significant changes to BMI/BMI z-scores following intervention (Davis et al., 2009a, Wengle et al., 2011, Resnicow et al., 2005, Tsiros et al., 2008, Kitzman-Ulrich et al., 2009). Two of these interventions without BMI changes included only adolescent girls (Resnicow et al., 2005, Kitzman-Ulrich et al., 2009), although the background of the participants differed between trials. Steele et al. (2012) found no change in the family-based intervention group and actually showed an increase in BMI z-scores in the brief individual family intervention. In this study, the same intervention was offered to children and adolescents aged 7-17 years and the children demonstrated reductions in BMI z-
scores but this was not observed in adolescents (Steele et al., 2012). Thus the lack of findings for adolescents might suggest that the intervention was not appropriately tailored to this age group.

BMI z-scores and BMI changes were also measured between groups in some studies. In studies using a control group, seven trials reported a significant group by time effect for BMI z-scores (DeBar et al., 2012, Saelens et al., 2002, Ball et al., 2011, Jiang et al., 2005, Johnston et al., 2007, Diaz et al., 2010, Janicke et al., 2008a), although Ball et al. (2011) and Saelens et al. (2002) only found a difference in those who had completed the whole intervention and Janicke et al. (2008a) only in one intervention arm. A further three trials showed a significant group by time effect for BMI (Sarvestani et al., 2009, Park et al., 2007, Savoye et al., 2007). The weight of the evidence suggests that most multicomponent interventions are effective at achieving modest reductions in BMI and BMI z-scores. The randomised controlled trials showed generally positive group by time effects for the experimental groups, supporting the effectiveness of interventions in overweight adolescents.

2.3.1.2 Other anthropometric outcomes (post-intervention)

Other anthropometric measures are often used to understand changes in body composition. Percent body fat and waist circumference were routinely measured in about half of the trials included in this review. Of the 16 trials measuring percent body fat, six studies reported a reduction in mean percent body fat of 1-5% (Bean et al., 2011, Woolford et al., 2011b, Rynders et al., 2012, Nemet et al., 2006, Knopfli et al., 2008, Diaz et al., 2010) and three reported differences between groups in percent body fat (Park et al., 2007, Savoye et al., 2007, Diaz et al., 2010). In regard to waist circumference, six of 11 studies found reductions in absolute means of 2-5cm (Shaibi et al., 2012, Shrewsbury et al., 2011a, Park et al., 2007, Panagiotopoulos et al., 2011, Diaz et al., 2010, Tsiros et al., 2008) and a group by time effect for waist circumference was seen in three studies (Kong et al., 2013, Diaz et al., 2010, Park et al., 2007). Other anthropometric measures, such as weight trajectory or waist-to-height ratio, were not routinely measured, making
comparisons difficult. Four studies reported reductions in mean body weight (Nemet et al., 2006, Karner-Rezek et al., 2013, Knopfli et al., 2008, Eliakim et al., 2002), and four demonstrated a between group effect for body weight (Park et al., 2007, Nemet et al., 2006, Sarvestani et al., 2009, Savoye et al., 2007). Some authors reported a reduction in the percent overweight in the intervention group (Lloyd-Richardson et al., 2012), a difference between groups for BMI percentile (Nemet et al., 2006, Kong et al., 2013) or a decrease in weight trajectory using a short waitlist control period (Panagiotopoulou et al., 2011). Other reported changes include a difference in arm circumference between groups (Sarvestani et al., 2009), reduction in waist-to-height ratio (Shrewsbury et al., 2011a) and group differences between waist-to-hip ratio (Park et al., 2007). There is inconsistent evidence to support changes in percent body fat and waist circumference following adolescent participation in multicomponent interventions. The lack of routine measures of other aspects of body composition, such as percent overweight, makes it difficult to summarise this part of the evidence.

2.3.1.3 Metabolic outcomes (post-intervention)

Data regarding metabolic outcomes is useful to understand how interventions can impact on physiological processes. Nine studies measured metabolic outcomes such as blood cholesterol, triglycerides and insulin sensitivity (Shrewsbury et al., 2011a, Kolsgaard et al., 2011, Jiang et al., 2005, Bean et al., 2011, Park et al., 2007, Savoye et al., 2007, Panagiotopoulou et al., 2011, Kubicky et al., 2012, Shaibi et al., 2012). Four reported reductions in total cholesterol (Shrewsbury et al., 2011a, Kolsgaard et al., 2011, Jiang et al., 2005, Bean et al., 2011), with two further trials reporting a difference in cholesterol between groups (Park et al., 2007, Savoye et al., 2007, Jiang et al., 2005). One trial showed a mean reduction in triglyceride levels (Bean et al., 2011), two trials also showed group by time effects for reductions in triglyceride levels (Park et al., 2007, Jiang et al., 2005), two showed reductions in absolute fasting insulin (Panagiotopoulou et al., 2011, Kubicky et al., 2012), one showed improvements in insulin sensitivity (Shaibi et al., 2012), and three found group by time effects for fasting insulin (Savoye et al., 2007, Kolsgaard et al., 2011, Park et al., 2007). It seems that some small but positive metabolic changes are achievable in
multicomponent interventions. However, the lack of consistent measurement of these outcomes limits the generalisations that can be made.

2.3.2 Immediate dietary outcomes (post-intervention)

Of the trials reporting anthropometric changes, only 16 also reported dietary outcomes immediately post-intervention (see table 2.3), with three trials not reporting dietary outcomes despite collecting dietary data (Kubicky et al., 2012, Woolford et al., 2011b, Jelalian et al., 2010). None of the 16 trials that reported dietary change had detailed data for all of the components of diet; namely energy intake, food group intake, nutrient intake and eating behaviours. Fourteen interventions did not measure dietary change and so had no dietary outcomes to report (Burguera et al., 2011, Diaz et al., 2010, Eliakim et al., 2002, Jiang et al., 2005, Johnston et al., 2007, Knopfli et al., 2008, Kolsgaard et al., 2011, Nemet et al., 2006, Panagiotopoulos et al., 2011, Resnicow et al., 2005, Rynders et al., 2012, Savoye et al., 2007, Steele et al., 2012, Weigel et al., 2008).

2.3.2.1 Energy intake (post-intervention)

Energy intake was reported in nine studies (Bean et al., 2011, Davis et al., 2009a, Tsiros et al., 2008, Janicke et al., 2008a, Kitzman-Ulrich et al., 2009, Karner-Rezek et al., 2013, Park et al., 2007, Saelens et al., 2002, Kong et al., 2013). Bean et al. (2011) reported a mean reduction in energy intake of 2,019 kJ/day (483 kCal) for participants, although these results were only significant for boys. Davis et al. (2009a) showed a statistically significant reduction in energy intake for one intervention group (-1471 kJ, 352 kCal), who received the nutrition intervention and strength training condition. However, the second intervention group received the same nutrition intervention but without the strength training, and this group did not reduce their energy intake as compared to the control group. Thus, the ability to attribute the change to the nutrition intervention is limited (Davis et al., 2009a). Tsiros et al. (2008) and Janicke et al. (2008a) both showed a reduction in energy intake in the intervention group (~2000 kJ, 478 kCal), although this did not differ from the control group. Kitzman-Ulrich et al. (2009) showed that adolescents in one intervention group demonstrated a greater decrease in energy intake (-1525 kJ, 365
kCal) as compared to another similar but more intensive intervention group and the control group. Karner-Rezek et al. (2013) did not report energy change but showed that energy intake was lower than expenditure following intervention. Three studies showed no change in energy intake following intervention (Park et al., 2007, Saelens et al., 2002, Kong et al., 2013). The evidence suggests likely moderate reductions in energy intake following intervention. However, these data have not been considered in view of the likely underreporting by participants, thus any reported changes may not be clinically important.

2.3.2.2 Food groups (post-intervention)

Food group analysis is particularly hard to compare between trials because of different definitions of food groups and servings. For junk foods, Shaibi et al. (2012) showed a significant reduction of 1.3 servings of dietary fat, whilst (Shrewsbury et al., 2011a) reported a significant reduction in frequency of consumption of less healthy foods including high fat meat products, potato crisps, and sugary drinks. Conversely, Kong et al. (2013) found that no between-group differences existed for sweetened beverage consumption post-intervention. Wengle et al. (2011) showed a significant overall reduction in consumption of high energy foods (-0.9 servings) and snacks (2.9 servings) for both intervention groups. In this study, both intervention groups received a one day workshop and four additional nutrition and activity counselling sessions, with one group linked with individual mentors who met with the adolescents about 14 times during the study period to provide additional support. When the dietary data was compared between groups, there was a significant difference but in the opposite direction than expected, with the non-mentored group making significant reductions in high energy foods and fast food consumption and the mentored group not making any changes (Wengle et al., 2011).

For fruit and vegetable intake, Shaibi et al. (2012) showed no change in consumption levels following intervention as did Kong et al. (2013), while Bean et al. (2011) found that combined servings of fruit and vegetables increased by 0.6 servings. Shrewsbury et al. (2011a) reported a significant improvement in the
percentage of adolescents who met dietary guidelines for fruit and vegetable intake (+12% for both food groups), although this was measured using a short questionnaire and may be an overestimation. The outcomes from these trials show some positive reductions in junk food intake, although minimal changes to fruit and vegetable consumption have been reported. Given the different assessment methods and reporting of the data, it is difficult to understand how effective these trials have been at changing food group intakes post-intervention.

2.3.2.3 Nutrient intake (post-intervention)

The majority of studies did not report detailed nutrient data, which limits understanding of specific changes made. Of those who did report nutrient outcomes, Tsiros et al. (2008) showed reductions in fat (-17.9g) and carbohydrate intake in the intervention group. Bean et al. (2011) showed reductions in intakes of total fat (24.0g), saturated fat, cholesterol, carbohydrate, sugar and sodium, as well as an increase in fibre intake. Davis et al. (2009a) showed reductions in carbohydrate intake and fat for one nutrition intervention group but not the other, and found no changes in intakes of sugar protein or fibre. Three studies reported no change in nutrient intake (Ball et al., 2011, Park et al., 2007, Coppins et al., 2011) and Saelens et al. (2002) reported no change in energy provided by fat. The evidence suggests some effect on nutrient intake following intervention, with reductions in fat the most common positive outcome observed. However, it is difficult to understand how nutrient changes have occurred, without the context provided by food group data.

2.3.2.4 Eating behaviours (post-intervention)

Eating behaviours are also measured differently between trials and reported using different structures. For example, Wengle et al. (2011) reported an overall reduction in fast food restaurant visits following intervention (-0.8 visits/week) whilst DeBar et al. (2012) reported no change in frequency of fast food restaurant visits. DeBar et al. (2012) found a difference between intervention and control groups for frequency of family meals, with the intervention group reporting less reduction in the frequency of family meals. Shrewsbury et al. (2011a) reported an
improvement in the proportion of adolescents who met dietary recommendations for breakfast consumption (9%), whilst Sarvestani et al. (2009) reported significant differences for emotional eating, external eating and restrained eating between intervention and control groups, and Saelens et al. (2002) reported no group by time effects for weight-related behaviours. There are some positive indicators of modest behaviour change following intervention in overweight adolescents, but too few consistent results to draw firm conclusions about how overweight adolescents may change their diet.

2.3.2.5 Summary of effectiveness of multicomponent interventions at post-intervention

Overall, multicomponent adolescent obesity interventions appeared to achieve immediate statistically significant but modest reductions in BMI and/or BMI z-score. Changes in percent body fat and waist circumference were inconsistent, as were metabolic changes. The conclusions that can be drawn from reported dietary outcomes are limited by the use of different dietary measures between trials and an overall lack of detailed outcome reporting. It seems that some positive changes in food groups and eating behaviours can be achieved, but the magnitude is small.

2.3.3 Anthropometric outcomes between post-intervention and 12 months

The extent of post-intervention measures differ between trials and the following information relates to overweight adolescent interventions with further measures taken between post-intervention and 12 months post-intervention. The 12 trials include seven interventions delivered in the USA, two in Australia and two in México (see table 2.3). There is a spread of settings with three interventions each run in a primary care setting, research setting and community centre, two at a weight management clinic and one at a school.

2.3.3.1 BMI z-scores/BMI (<12 months)

Six trials measured BMI z-scores and BMI for less than 12 months following intensive intervention (Eliakim et al., 2002, Diaz et al., 2010, Savoye et al., 2007,
Resnicow et al., 2005, Lloyd-Richardson et al., 2012, Nguyen et al., 2012b). Eliakim et al. (2002) and Diaz et al. (2010) reported no further changes in BMI from post-intervention measures, thus the reduction from baseline was maintained at 3 months post-intervention. At 6 months post-intervention Savoye et al. (2007) showed a statistically significant reduction in BMI from baseline in the intervention group (-1.70), whilst Resnicow et al. (2005) showed no change in BMI from baseline or post-intervention levels. At 8 months post-intervention Lloyd-Richardson et al. (2012) reported a reduction in BMI z-scores from baseline (-0.22), as did Nguyen et al. (2012b) (-0.09) at 10 months post-intervention.

For trials measuring BMI, eight studies reported changes in BMI between post-intervention and less than 12 months post-intervention (Tsiros et al., 2008, Johnston et al., 2007, Diaz et al., 2010, Saelens et al., 2002, Savoye et al., 2007, Janicke et al., 2008a, DeBar et al., 2012, Davis et al., 2012). At 2.5 months post-intervention, Tsiros et al. (2008) showed significant group by time improvements in BMI in favour of the intervention group. Similarly, at three months post-intervention (Johnston et al., 2007) reported group by time effects for BMI and BMI z-scores in favour of the intervention group. At three months post-intervention (Diaz et al., 2010) reported a significant difference between the intervention and control groups, but Johnston et al. (2007) did not report group by time effects. Saelens et al. (2002) found that BMI z-score difference between groups remained significant at three months, although group by time effects were not significant, thus the results do not necessarily account for the effect of the intervention. At six months post-intervention, Savoye et al. (2007) reported significant differences group by time effects for BMI as did Janicke et al. (2008a) and DeBar et al. (2012).

The only study to find no change in body composition during medium-term follow up was Davis et al. (2012) at eight months post-intervention. Therefore, the evidence for body composition change up to 12 months post-intervention seems to suggest that multicomponent interventions are generally successful at sustaining modest changes in BMI and BMI z-scores.
2.3.3.2 Other anthropometric and metabolic outcomes (<12 months)

Seven studies reported additional changes in anthropometric outcomes such as percentage body fat or metabolic changes such as blood lipid levels for less than 12 months (Tsiros et al., 2008, Johnston et al., 2007, Diaz et al., 2010, Savoye et al., 2007, Lloyd-Richardson et al., 2012, DeBar et al., 2012, Nguyen et al., 2012b). At 2.5 months post-intervention Tsiros et al. (2008) found significant group differences for weight, fat mass, abdominal fat, and hip circumference, however, improvements in percentage body fat and waist circumference were not significant. At 3 months post-intervention Johnston et al. found a significant reduction in percent body fat (-2.3%) but no change in metabolic outcomes Johnston et al. (2007), while Diaz et al. (2010) also showed reductions in percent body fat (-2.3%). In the latter study, waist circumference was also reduced and differed between intervention and control group and there was a group by time effect for weight (Diaz et al., 2010). At six months post-intervention Savoye et al. (2007) found significant group differences for body weight, percent body fat, cholesterol and fasting insulin and Lloyd-Richardson et al. (2012) showed a reduction in percent overweight (-6.0%). Savoye et al. (2007) also showed no change to other lipids or fasting glucose. DeBar et al. (2012) found no six month differences in any of their metabolic outcomes and Nguyen et al. (2012b) found reductions in waist to height ratio, total cholesterol and triglycerides at 10 months post-intervention. There are too few studies reporting the same anthropometric or metabolic changes to draw conclusions about the effectiveness of multicomponent interventions for less than 12 months post-intervention. The existing evidence suggests that some changes are achievable, although the magnitude of change is generally small.

2.3.4 Dietary outcomes between post-intervention and 12 months

There were only five studies reporting dietary outcomes between the post-intervention measures and 12 months post-intervention (Tsiros et al., 2008, Saelens et al., 2002, Janicke et al., 2008a, Davis et al., 2012, Nguyen et al., 2012b), thus
limiting the ability to fully evaluate the effectiveness of the majority of trials. Six trials did not measure diet (Johnston et al., 2007, Savoye et al., 2007, Eliakim et al., 2002, Diaz et al., 2010, Lloyd-Richardson et al., 2012, Resnicow et al., 2005) and a further study by DeBar et al. (2012) did not collect six month dietary data despite previous data collection. There were no comprehensive short-term reports of diet change, and no reporting of food groups during this period.

2.3.4.1 Energy intake (<12 months)

Energy intake change was measured in three trials, although none accounted for potential underreporting. At 2.5 months post-intervention Tsiros et al. (2008) reported reductions in total energy intake in the intervention group, but this did not differ from the control group. At three months post-intervention there was also a lack of a group by time effect for energy in the trial described by Saelens et al. (2002). Janicke et al. (2008a) showed significant within-group reductions in energy intake but the two different intervention conditions were not compared to each other or the control. Thus, there is no evidence from these trials to support the effectiveness of multicomponent interventions in sustaining reductions in energy intake for less than 12 months during the maintenance period.

2.3.4.2 Nutrient intake (<12 months)

Nutrient intake was measured between post-intervention and less than 12 months post-intervention in three trials (Tsiros et al., 2008, Saelens et al., 2002, Davis et al., 2012). Tsiros et al. (2008) reported reductions in absolute carbohydrate, fat and sugar intake in the intervention group but this did not differ between groups, nor did Saelens et al. (2002) find any group differences for fat intake at three months. Davis et al. (2012) showed no effect of intervention on nutrient intake at eight months. From this limited evidence, it appears that lifestyle interventions are not effective at sustaining changes in nutrient intake for less than 12 months post-intervention, however more studies are needed to confirm this.
2.3.4.3 Eating behaviours (<12 months)

Eating behaviours were assessed between post-intervention and less than 12 months post-intervention in three trials (Tsiros et al., 2008, Saelens et al., 2002, Nguyen et al., 2012b). At 2.5 months post-intervention Tsiros et al. (2008) found significant reductions in soft drink consumption for the intervention group as compared to the control group, while Saelens et al. (2002) found no differences between groups for weight-related behaviours. At 10 months post-intervention Nguyen et al. (2012b) showed less frequent consumption of high-fat meat products, potato crisps, and lunch but no other dietary changes. As there are such a small number of studies assessing eating behaviour change during the maintenance period, there is very limited evidence to suggest that multicomponent interventions routinely result in changes in eating behaviours.

2.3.4.4 Summary of dietary changes less than 12 months post-intervention

It is difficult to draw meaningful conclusions about dietary change less than 12 months following intervention with data available from only five studies. In essence, there did not appear to be any meaningful changes to energy or nutrient intakes. There were some positive changes reported in some eating behaviours but the magnitude appears small. Overall dietary change in this period appears minimal.

2.3.5 Long-term anthropometric outcomes (≥12 months)

There are very few adolescent obesity interventions reporting outcome measures of 12 months or greater post-intervention. Long-term maintenance of behaviour change or weight loss are the ultimate aims for any obesity intervention, however collecting such data is limited by high drop-out rates and a lack of intent-to-treat data for subjects who may not have been as successful with weight loss (Douketis et al., 2005, Stubbs et al., 2011, Fulton et al., 2001). The trials reporting long-term outcomes are summarised in Table 2.3 and include three trials from the USA (Lloyd-Richardson et al., 2012, Savoye et al., 2011, Steele et al., 2012), one from Australia (Nguyen et al., 2013) and one from the United Kingdom (Coppins et al., 2011). Four
had at least one component of the intervention delivered in a community setting (Lloyd-Richardson et al., 2012, Savoye et al., 2011, Nguyen et al., 2013, Coppins et al., 2011) and one was held solely in an outpatient clinic (Steele et al., 2012). Two trials exclusively targeted adolescents (Lloyd-Richardson et al., 2012, Nguyen et al., 2013) and three included younger participants (Savoye et al., 2011, Steele et al., 2012, Coppins et al., 2011).

2.3.5.1 Anthropometric and metabolic outcomes (≥12 months)

Anthropometric changes were measured in all five studies. Steele et al. (2012) actually found a significant increase in BMI z-scores for adolescents in the intervention groups at 12 months post-intervention. Savoye et al. (2011) showed differences between the control and intervention groups were maintained at 18 months for BMI z-scores (-0.16), BMI, percent body fat, weight and cholesterol. At 20 months post-intervention Lloyd-Richardson et al. (2012) showed a reduction from baseline in BMI z-scores (0.23) and percent overweight although no between-group differences were noted for the intervention groups. Nguyen et al. (2013) showed similar reductions from baseline were maintained at 22 months post-intervention for BMI z-scores (-0.13), waist to height ratio, total cholesterol and triglycerides. Coppins et al. (2011) found significant reductions from baseline BMI (-0.13) and waist circumference were maintained at 12 months post-intervention in one intervention group, although the design of this study makes it hard to compare between group changes. In this study, one group received 12 months of intervention followed by 12 months of no contact, whilst the other group received 12 months of no contact followed by 12 months of the same intervention as the first group. Final measures were taken at the end of the 24 month study period; which meant that the first group had a 12 month follow-up measurement but second intervention group completed only immediate post-intervention measures at this time (Coppins et al., 2011).

2.3.5.2 Summary of long-term outcomes

The dearth of detailed long-term reporting of outcomes in overweight adolescent trials limits the conclusions that can be drawn regarding the effectiveness of
interventions at achieving long-term body composition or dietary change. In the existing trials, it appears that BMI or BMI z-score measures were generally reduced from baseline and maintained following intervention, although the magnitude of these changes were generally small. For dietary outcomes, there was insufficient reporting of dietary outcomes to indicate how diet changed in the long-term following intervention. In the two trials that reported dietary outcomes, only a small number of eating behaviours were changed from baseline, and these differed between the trials. Overall, there were very modest long-term changes in body composition and minimal changes reported in diet for overweight adolescents.

2.3.6 Long-term dietary outcomes (≥12 months)

There are very few studies reporting long-term dietary changes in overweight adolescents. Coppins et al. (2011) found a significant between group effect for quantity of potato chips consumed, however, this was the only dietary outcome reported from the study. The authors used a combined food and physical activity diary to measure intake, in which the method for estimating consumption was not validated. Thus, the finding for potato chips may not be accurate. The dietary finding is also limited by the intervention design, which included carryover effects in a within subject design. Although the authors found that potato chip consumption was less in the ‘no contact then intervention’ group than the ‘intervention then no contact’ group, this comparison is not accurately comparing long-term change because the first group had only just completed the intervention while the second group had completed 12 months of maintenance (Coppins et al., 2011). At 20 months post-intervention, (Lloyd-Richardson et al., 2012) reported a reduced number of nutrition journals being kept by participants, although the contents of these were not analysed. Nguyen et al. (2013) reported a small number of dietary changes at 22 months post-intervention, including less frequent consumption of high-fat meat products (odds ratio 0.22) and lunch every day (OR 0.49), and a higher likelihood of never or rarely consuming fruit juice (OR 2.47). Two interventions for overweight adolescents with long-term follow up had no measures of dietary intake (Steele et al., 2012, Savoye et al., 2011).
2.3.6.1 Summary of effectiveness of multicomponent interventions in changing diet for overweight adolescents

Whilst guidelines exist for the broad dietary management of adolescent obesity, there are too few observational or intervention studies with adequate detail regarding energy, macronutrient, micronutrient, food group and eating behaviour patterns or short-term or long-term changes following intervention, to provide strong evidence about the most effective ways to intervene (Collins et al., 2006, Barlow, 2007, National Health and Medical Research Council, 2013b). Further, none of the studies above described the adherence to dietary prescription used in the intervention, making it difficult to understand the effectiveness of the dietary intervention. This contributes further to the lack of consensus regarding the best approach for dietary intervention. With more detailed dietary data, nutrition messages can potentially be more targeted to help adolescents set relevant and specific goals, potentially one of the most efficacious ways to promote healthy behaviour change (Locke and Latham, 1990, Shilts et al., 2004a).

Identified gap: There is a lack of good evidence for how overweight adolescent diet changes following intervention.

2.3.7 Review of trials similar to CAFAP

Whilst 33 studies report an overweight adolescent intervention with a dietary component, five were selected for a more detailed review of the nutrition component and outcomes as they reflect the style of the trial on which this thesis is based. These trials are referred to regularly in the results and discussion chapters and are summarised in table 2.4.

Bean et al. (2011) reported on an uncontrolled study of the six month TEENS intervention delivered between 2004 and 2007. Participants included 67 obese adolescents aged 12-15 years. Participants were recruited following referrals from paediatricians, family doctors, school health nurses or if they referred themselves. The intervention was conducted in Virginia, USA and delivered in a university-based
<table>
<thead>
<tr>
<th>Study</th>
<th>n and subjects</th>
<th>Dietary assessment</th>
<th>Dietary under-reporting analysis</th>
<th>Diet intervention</th>
<th>Use of theory</th>
<th>Results (BMI/z, WC, diet/PA change)</th>
<th>Follow up</th>
<th>Comments</th>
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<tr>
<td>Nguyen et al. (2013) LOOZIT program</td>
<td>151 overweight and obese adolescents aged 13-16</td>
<td>15 item FFQ, with additional dietary questions</td>
<td>None</td>
<td>Healthy lifestyle approach including addressing healthy food choices and eating patterns, preparation and tasting of healthy foods, food groups, labels, lunch boxes, macronutrients</td>
<td>Social cognitive theory and Cognitive behavioural therapy</td>
<td>↓BMI z-score, ↓Waist to height ratio, ↓cholesterol and triglycerides, ↓frequency of consumption of high-fat meat products and lunch, ↑likelihood of never/rarely consuming fruit juice</td>
<td>22 months, booster sessions every 3 months, 6 months-newsletters and birthday cards sent</td>
<td>Additional therapeutic contact had no impact on outcomes, No measure of adherence to dietary intervention</td>
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<tr>
<td>Janicke et al. (2008a) Project STORY Comparison of family-based or parent only 16 week lifestyle program</td>
<td>71 overweight and obese children and adolescents aged 8-14</td>
<td>Youth adolescent FFQ (131 items) and Children’s Eating and Attitudes Test</td>
<td>None</td>
<td>Modified Stoplight Diet (limit high fat/sugar and increase FV).</td>
<td>Not described. Strategies include goal setting, contracting, self-monitoring and incentives</td>
<td>↓BMI z-score in both intervention groups at 6m follow up, ↓EI (both intervention groups)</td>
<td>6 months-newsletters and birthday cards sent</td>
<td>About 1/3 of participants were &lt;11 years old, No measure of adherence to dietary intervention</td>
</tr>
<tr>
<td>Bean et al. (2011)</td>
<td>67 obese adolescent s aged 12-15</td>
<td>2x 24-hour recalls</td>
<td>Calculate d EI:BMR = 1.02 at baseline. Ratio at 6 months decrease d to 0.80 but authors stated this was to be expected as still active in the program</td>
<td>30 min dietitian session every 2nd week for 12 sessions. Includes education re: food pyramid, labels, hunger cues, snacking, portions, energy balance, FV, eating out, shopping, cravings</td>
<td>Mainly a cognitive behavioural approach</td>
<td>↓BMI, ↓BMI z-score, ↓% body fat, ↓EI (-483 kCal/day), ↓total fat, sat fat, cholesterol, carb, sugars, sodium. ↑FV (0.6 serving) ↑fibre. When split by gender only %energy from fat and FV remained significant for boys Cholesterol and sodium reduction remained significant for girls</td>
<td>6 months, no details.</td>
<td>No control period/group Immediate post intervention measures only High proportion of African American youth. No formal underreporting analysis No measure of adherence to dietary intervention</td>
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<tr>
<td>Study</td>
<td>Participants</td>
<td>Methods</td>
<td>Outcomes</td>
<td>Duration</td>
<td>Maintenance</td>
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<tr>
<td>Davis et al. (2009a)</td>
<td>54 overweight and obese Latino adolescent s aged 14-16 years</td>
<td>3 day food records, Modified carbohydrate nutrition class once per week. Aim for &lt;10% E from added sugar and 14g/1000 kCal of fibre/day</td>
<td>No effect on body composition. Mainten ance period used self-determination theory. No effect on body composition ↓EI, fat and carbohydrate intake in group with strength training as compared to control, but not in group without strength training</td>
<td>8 months, group sessions or monthly newsletters</td>
<td>No difference in outcome for different maintenance In a sub group of females, nutrition outcomes differed to those reported here (less effect)</td>
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<td>Savoye et al. (2007)</td>
<td>209 overweight children and adolescent s aged 8-16 (119 at 12months, 45 completed 24 months)</td>
<td>None, Non-diet approach-focus on low fat, nutrient dense, moderate portions, good food choices, labels, taking lunch, recipes</td>
<td>Theory not described but used coping skills training. ↓BMI z-score ↓BMI ↓% Body fat ↓insulin resistance at 24m follow up</td>
<td>6 months-2 sessions per month. Further 12 months- no active intervention.</td>
<td>Did not split children and adolescents for analysis. No measure of adherence to dietary intervention</td>
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*WC: waist circumference  
*FV: servings of fruit and vegetables  
*EI: energy intake
weight management clinic. The six month program included three exercise sessions per week and a session with the dietitian every two weeks. The nutrition component was a healthy eating approach. The content was based on the food pyramid and included goals of increasing fruit and vegetable intake, reducing sugar-sweetened beverage intake, eating breakfast regularly and eating at home with the family. Strategies included label reading, identifying hunger cues, reducing portion size, understanding energy balance, dealing with cravings and making healthy choices when eating out. Participants were encouraged to self-monitor their diet and set their own nutrition-related goals. The research team administered two multi-pass consecutive 24-hour recalls at baseline and post-program and at each time point these were entered into nutrient analysis software and then averaged. Analysis was completed for energy, macronutrients, key micronutrients and intake of fruits and vegetables (combined). There was no measure of adherence to key messages in this intervention. Total energy intake reduced significantly after six months along with intakes of total fat, saturated fat, cholesterol, carbohydrates, sugar and sodium. Percentage energy contribution of fat and carbohydrate did not change, although protein contribution increased. Fruit and vegetable intake increased by a total of 0.6 serves. When split by gender most results remained significant, with an additional reduction in percentage of energy contribution from fat for males. Fruit and vegetable intake was no longer different from baseline to post-intervention for females but remained significant for males, potentially influenced by their intake of fruit and vegetables at baseline being much lower than for females. The EI:BMR ratio was 1.02 at baseline and this ratio decreased at 6 months to 0.80. The authors describe this reduction as expected and suggest it was evidence for reducing energy intake, as the adolescents were still actively involved in the intervention. However, this assumption is not evidence-based and there is the potential that this ratio reflects the existence of underreporting. The authors also describe anthropometric changes that support reductions in energy intake, such as a BMI z-score reduction and blood lipid changes consistent with reported fat intake changes. There was no further follow up or maintenance program offered in this trial. Although these results are promising, longer-term data is needed to understand which adolescent nutrition behaviours are sustained during the
maintenance period and a measure of adherence is needed to understand the effectiveness of the dietary component. Importantly, there was no comparison group to compare these changes and rule out potential time effects.

Janicke et al. (2008a) conducted a randomised controlled clinical trial with 93 overweight and obese children and adolescents aged 8-14 years. Participants were recruited from flyers sent in the mail, school brochures, and community and school presentations. This trial was run in rural Florida, USA at local community sites. The intervention was conducted weekly for 8 weeks and then every fortnight for an additional 8 weeks. There were three groups in this study, used to compare two different interventions. The first group received a family based obesity treatment, the second group received a parent-only obesity treatment and the third group was a waitlist control group. The content of the family based intervention was very similar to the parent only intervention; except that parents and children both participated in the family intervention. Nutrition content was based on a modified Stoplight diet, and focussed on limiting foods high in fat and sugar and increasing fruits and vegetables. Children and parents were encouraged to set nutrition-related goals and monitor their daily eating habits in a log book, although these were not analysed for intake data. In the family-based group, separate sessions were held for parents and children but the same content was covered. Parents reviewed their own goals each session and were taught about nutrition, physical activity and behaviour management strategies. In each session children reviewed their goals, participated in physical activity and prepared a healthy snack. Parents and children were weighed at every second session. The parent-only group received similar content to the parents in the first group, but additional content was included regarding how to work with their children to set goals at home. An FFQ was used to assess energy intake and eating behaviours for the children and adolescents. Follow-up assessments were completed immediately post intervention and six months following intervention conclusion. At the final assessment, 24 participants remained in the family based group, 26 remained in the parent-only group and 21 in the waitlist control group. Analysis of the FFQ data showed that there were no significant group by time differences for energy intake. Within group analysis
showed significant reductions in energy intake in all three groups immediately post-intervention. At the six month follow up, only the two intervention groups had maintained a reduction from baseline energy intake. Immediately following intervention children in the parent only group demonstrated a greater reduction in BMI z-scores score than the control group, however this was not true for the family-based group. At 6-months post-intervention both intervention groups demonstrated a greater decrease in BMI z-scores score from baseline than the control group. In this study, the sample was too small to split the group into children and adolescents, but post hoc testing suggested that for adolescents, those allocated to the family-based group experienced a greater decrease in overweight status than those in the parent-only group. In the last half of the intervention, participants attended less frequent sessions, which is similar to some maintenance periods. However, post-intervention testing only occurred at the end of this period, so it cannot be considered a true maintenance period. This study contributes important evidence regarding the effect of intervention on energy intake in obese adolescents but given a lack of other nutritional intake data, it remains unclear about how this energy reduction was achieved in the intervention groups, nor whether the modified Stoplight diet was adhered to. The results may also be influenced by the small sample size and the inclusion of younger children in the analysis.

Davis et al. (2009a) conducted a randomised control trial with a group of 54 overweight and obese Latina adolescents aged 14-18 years. The intervention ran for 16 weeks and was delivered at a lifestyle intervention laboratory in California, USA. Adolescents were allocated to a nutrition intervention, a nutrition plus strength training intervention, or a control group. All intervention groups attended a weekly nutrition class, whilst those randomised to a training group also attended twice-weekly exercise sessions. Parents were asked to attend at least four separate education classes. Nutrition education had a nutrient focus. The two goals of dietary intervention included modifying carbohydrate intake to reduce added sugar intake to less than 10% of total energy and achieve a fibre intake of 14g/1000 kCal. Adolescents in both intervention groups received at least four motivational
interviewing sessions to encourage intrinsic motivation for change. Three day food records were used to assess changes in dietary intake although adherence to the modified carbohydrate diet was not reported. Further, there was no analysis to consider the impact of potential underreporting. Immediately following intervention, a reduction in energy, fat and carbohydrate intake was reported in the strength training group as compared to the control group, but there was no difference between the control group and nutrition only group. This is unexpected given the nutrition group received the same education as the nutrition plus strength training group and completed the same dietary assessment, yet did not show the associated changes in nutrition outcomes. There was no overall effect on body composition for all groups. This differed to results from the pilot trial involving only Latina females (n=38), in which changes to BMI z-scores differed between the groups receiving different training regimens. There were also similar dietary inconsistencies reported in this pilot trial despite the intervention groups all receiving the same nutrition intervention. There was no maintenance period in either of the studies. Dietary adherence data and longer follow up are needed to understand the effect of the intervention.

Shaibi et al. (2012) conducted an uncontrolled pilot study of a 12 week intervention with 15 obese Latino adolescents aged 14-16 years. Participants were recruited through an existing school-based network. The intervention was delivered at a YMCA community centre in Arizona, USA. Adolescents attended three exercise sessions per week plus a weekly lifestyle education session. Parents were involved in the lifestyle education sessions. The dietary component of the intervention was based on a healthy eating approach and included education regarding regular consumption of breakfast and reduced consumption of fast food, snacks, fat and sweet drinks. Teaching strategies included a shopping tour, recipe modifications, portion size education and setting of nutrition goals. Despite the very small numbers in this trial, it has been included in this summary because of the reporting of food group data and a very similar dietary approach to that used in the intervention in this thesis. Dietary intake was assessed with a brief dietary assessment tool developed specifically for Hispanics to measure fruit, vegetable and
fat intake, however the reliability of this tool has only been assessed in adults (Wakimoto et al., 2006). (Shaibi et al., 2012) reported no change in fruit or vegetable intake immediately post intervention, however a significant reduction in fat intake was observed from 3.3 (0.3) serves per day to 2.0 (0) serves per day. This measure of intake should be treated with caution given the lack of reliability or validity data for its use in obese adolescents. A further measure of dietary adherence would have been useful to understand the effectiveness of this approach, and longer term dietary data is needed to understand how long these changes were continued. For other outcome measures, participants recorded significant reductions in BMI z-score and waist circumference, as measured immediately after this 12 week intervention. There was no maintenance period included in this study.

Savoye et al. (2011) conducted a randomised controlled trial with 209 children and adolescents aged 8-16 years. Participants were recruited from an existing obesity clinic and assigned to an intervention or control group. The intervention was delivered on school grounds but after school hours, in Connecticut, USA. Participants attended twice weekly for six months and every second week for a further six months. Parents were involved in the session with the adolescents and received further education regarding behaviour modification while the adolescents participated in physical activity. The nutrition component of this program was based on a healthy eating approach and included education regarding choosing low fat, nutrient-dense foods in appropriate portion sizes. Strategies included label reading and recipe modification. The control group had an individual appointment with the dietitian every six months and included strategies to reduce energy intake. There was no assessment of diet in this trial as the authors described this as contradicting the non-diet approach. Follow-up was completed immediately, six months, and 18 months following intensive intervention. The six months following the intensive intervention was similar to a maintenance period, although the authors still classified it as intervention. There were group by time effects for BMI z-score, body fat percent and total body fat after this maintenance period and this was sustained at 18 months post-intervention. The interpretation of this study is severely limited
by the absence of measures of diet, physical activity or psychosocial changes for participants, which hampers translation of strategies into other interventions.

Shrewsbury et al. (2011a) conducted a two year randomised controlled trial with 151 overweight and obese adolescents aged 13-16 years. Participants were recruited using the media and advertising in schools, with health professionals and through community organisations. The intervention was delivered in community health centres in New South Wales, Australia. Participants and parents attended weekly sessions for seven weeks, and all participants received the same intervention, with randomisation not occurring until the maintenance period. The sessions included a focus on making healthy food choices, increasing physical activity and reducing sedentary activity and behaviour change strategies (Shrewsbury et al., 2009). The content of the nutrition component was delivered over two sessions and included information regarding macronutrients and food groups; as well as strategies for reducing consumption of non-core foods, fat and sweetened beverages and strategies for increasing fibre and vegetable intake and consuming a healthy breakfast. There were also practical activities regarding food label reading and measuring fat and sugar content of various food and drinks (Shrewsbury et al., 2009). Dietary intake was measured using a 15 item FFQ with additional items relating to relevant eating behaviours. Follow up measures were collected at post-intervention, 10 months post-intervention and 22 months post-intervention. Immediately following intervention, there were significant improvements in the percentage of adolescents meeting Australian dietary guidelines regarding frequency of consumption of fruit, vegetables, water and breakfast. Further, statistically significant reductions were seen in some eating behaviours such as consumption of high fat meat products, potato crisps and sugary drinks. Following intervention participants were randomised to receive a maintenance program of either additional therapeutic contact in the form of phone coaching and text/ email or no further contact (Nguyen et al., 2013). The contact occurred fortnightly and consisted of 14 phone calls and 32 electronic messages (email and SMS) over 21 months, with an average of one SMS sent per month. At 10 months post-intervention, there were no dietary differences between the
maintenance groups (Nguyen et al., 2012b). Overall participants reported statistically significant reductions from baseline in frequency of some foods such as high fat meat products and potato crisps, and less frequent consumption of lunch. There were no other changes detected in eating behaviours from the 15 items identified in the FFQ and additional eating behaviour questions. At 22 months post-intervention participants reported statistically significant dietary changes from baseline including reducing their intake high fat meat products to once a week or less, never or rarely consuming fruit juice and eating lunch every day (Nguyen et al., 2013). There were no differences between the maintenance groups. Statistically significant reductions in BMI z-score and waist-to-height ratio were found at all assessment points when compared to baseline. It is unclear whether the nutrition component, compared to physical activity component, of this program was effective in prompting these behaviour changes, as adherence to the key messages of the program were not measured. There was no control group or waitlist period during the intervention, so it remains unclear as to whether the dietary changes stem from the intervention or are just chance findings. Further, the impact of reporting socially desirable intakes following intervention was not acknowledged. The maintenance, albeit modest, of some dietary and body composition changes suggests an overall positive effect of this intervention.

2.3.8 Summary

Whilst there are a number of well-designed trials dedicated to evaluating multicomponent interventions for overweight adolescents, a number of gaps in the literature remain regarding how to best deliver such interventions. A key issue that affects all trials is the lack of strong evidence to guide intervention delivery, from recruitment through to maintenance stages. Further, there is insufficient evidence to describe what overweight adolescents actually eat, thus dietary interventions cannot yet be adequately tailored to suit this unique group. There is a lack of detailed description of existing dietary interventions and inadequate evaluation of the effectiveness of these components. The lack of detailed reporting of dietary data following the implementation of multicomponent interventions limits the understanding of how overweight adolescents can change their diet and there
remains insufficient evidence to describe how to best support these changes during the maintenance period.

Based on these key identified gaps, this thesis will address the following aims:

- **Objective 1:** To investigate the perceptions of adolescents, parents and stakeholders regarding barriers and facilitators to recruitment, retention and maintenance associated with a healthy lifestyle program.
- **Objective 2:** To examine the patterns of dietary intake for obese adolescents entering a healthy lifestyle program.
- **Objective 3:** To provide a detailed description of the development of the dietary component of Curtin University’s Activity, Food and Attitudes Program (CAFAP).
- **Objective 4:** To assess adolescent dietary change for food groups, energy intake, nutrients, eating behaviours and adherence from immediately post-intervention to 12 months post-intervention.
- **Objective 5:** To evaluate the experiences of adolescents receiving text messaging support during the maintenance period.

The following chapters will report on five studies that address these five objectives. These five studies have been conducted as part of a broader research project evaluating Curtin University’s Activity, Food and Attitudes Program (CAFAP). Each of the study chapters have been written as research papers and four studies have been published in appropriate journals, with the fifth one under review. Following the chapters reporting the five studies, Chapter Eight provides an overall discussion on how these studies addressed the key aims of this thesis. Chapter Nine draws together the overall conclusions. The layout for this thesis is described in further below.

Each of the following results chapters are presented as the journal article that refers to a smaller study, within the greater research project. Due to the different nature of the studies, the relevant methodology has been reported separately in each chapter, to avoid duplication.
2.3.8.1 Overview of thesis
Figure 2.1 shows the outline of the studies included in this thesis. The figure depicts the timing of the studies, the participant numbers and the methods of data collection.
### Figure 2.1 Thesis structure

<table>
<thead>
<tr>
<th>Stages</th>
<th>Formative research</th>
<th>Waitlist control</th>
<th>Intervention</th>
<th>High intensity maintenance</th>
<th>Medium intensity maintenance</th>
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Chapter 3.0  Study A: Barriers and enablers

The information in this chapter has been published in BMC Pediatrics as follows:


This chapter includes analysis of barriers and enablers perceived by adolescents, parents and stakeholders in regard to participation in healthy lifestyle programs. Despite significant levels of overweight or obesity during adolescence, there is limited evidence regarding recruitment and engagement of adolescents in weight-management or healthy lifestyle interventions, or best-practice for encouraging long-term healthy behaviour change. A sound understanding of community perceptions, including views from adolescents, parents and community stakeholders, regarding barriers and enablers to entering and engaging meaningfully in an intervention is critical to improve the design of such programs.

This study included focus groups and semi-structured interviews conducted with adolescents (n=44), parents (n=12) and community stakeholders (n=39) in Western Australia. Three major topics were discussed to inform the design of more feasible and effective interventions: recruitment, retention in the program and maintenance of healthy change. Data were analysed using content and thematic analyses.

This study highlights significant barriers for adolescents and parents to overcome to engage meaningfully with weight-management or healthy lifestyle programs. A number of enablers were identified to promote ongoing involvement with an intervention. This insight into specific
contextual opinions from the local community can be used to inform the delivery of healthy lifestyle programs for overweight adolescents, with a focus on maximising acceptability and feasibility.

3.1 Background

3.1.1 Prevalence of adolescent obesity and associated risk factors

It is estimated that one quarter of adolescents in Australia are overweight or obese (National Health and Medical Research Council, 2013b, Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008) with adolescence recognised as a prime time for significant progression of obesity (Patton et al., 2011). It has been suggested that changes to environmental and societal factors such as a decrease in physical activity, an increase in sedentary behaviour and the availability of low cost high fat, high energy food have contributed to these high rates of overweight and obesity (Baur, 2002). Obesity during adolescence is related to adverse health outcomes including hypertension, orthopaedic complications, sleep apnoea, increased risk of Type II diabetes (Baur, 2002, Steinbeck, 2005), poor self-esteem and depression (Merten et al., 2008, Strauss, 2000). Adolescence is therefore a critical point for the implementation of effective prevention and management initiatives. The most recent Cochrane Review suggests that promoting a healthy lifestyle through a family-based program with a focus on improving diet and activity behaviours is the most effective way to manage overweight and obesity at this age (Oude Luttikhuis et al., 2009).

3.1.2 Importance of formative research prior to intervention

There have been a small number of high-quality long-term trials to evaluate family-based obesity management in adolescence, with most reporting limited success (Shrewsbury et al., 2009, Bean et al., 2011, Evans et al., 2009, Davis et al., 2009b, DeBar et al., 2012, Savoye et al., 2007, Janicke et al., 2008a, Steele et al., 2012). The literature suggests a trend of modest anthropometric improvements immediately
post-intervention, but an absence of evidence to suggest sustained long-term changes (Nguyen et al., 2012b, Nguyen et al., 2013, Savoye et al., 2011). Further, minimal information on behavioural changes by participants has been reported and with most research reporting on outcomes rather than the process measures such as methods used to attract participants or program delivery (Waters et al., 2011), there is limited evidence about how to achieve such changes. Thus how to most effectively and appropriately change the health trajectory for overweight adolescents remains unanswered. From efficacy, health services planning and ethical points of view, there is much to be gained from a more extensive evidence base in this area (Oude Luttikhuis et al., 2009).

3.1.2.1 Recruitment of overweight and obese adolescents

Nguyen et al. (2012a) reported articles in school newsletters and community newspapers as the most effective means of recruiting overweight adolescents, however, they stated that these two strategies alone would be insufficient to yield enough participants. Once adolescents or parents have learnt of a treatment option, there is even less information about the processes involved in the initiation of care. This is of concern as noted by a Canadian research team that suggest around 50% of referrals to weight management programs do not attend their first appointment (Ball et al., 2012).

3.1.2.2 Retention of overweight and obese adolescents

For those who do seek treatment, there is limited evidence regarding prevention of attrition and ways of keeping adolescents engaged. A review of the literature relating to attrition from paediatric weight management programs suggest that between 27% and 73% of participants drop out of interventions (Skelton and Beech, 2011). It appears that patients with greater health risks were more likely to drop out of treatment, as were ‘vulnerable’ families (e.g., minority groups, single parent families) although this was not conclusive (Skelton and Beech, 2011). Although all participants were thought to face some barriers to participation, it seemed that program non-completers perceived more barriers to participation than those who completed treatment (Brennan et al., 2012). Other family factors that may impact
on attrition included unmet expectations, too much information to learn, cost, and scheduling conflicts (Skelton and Beech, 2011, Brennan et al., 2012). There has been some success in the United States of America (USA) where the cost of participation has been offset by government funded health schemes however this retention strategy is costly and not universally accepted due to differing health care system protocols (Ball et al., 2012). In-depth interviews with paediatric clinicians suggest that while most health professionals recognise attrition as a major issue, there is no consensus about how to manage it (Skelton and Beech, 2011). Whilst some ideas for keeping families engaged in programs have been proposed, such as building positive relationships with program staff, meeting or managing parent and child expectations and building child confidence (Brennan et al., 2012, Skelton et al., 2012), there is insufficient detailed information on the opinions of adolescents and their families on what is important to maintain engagement in a program.

### 3.1.2.3 Maintenance following intervention

There is also a gap in the literature about how to encourage maintenance of healthy behaviour change post-program. In adults, clinical trials focussing on lifestyle components (activity and dietary behaviours) have demonstrated long-term successes with maintained reduction in weight (Douketis et al., 2005, Turk et al., 2009). The literature tends to have a greater focus on initial weight loss than ongoing weight maintenance and reporting of longer term outcomes is limited by high drop-out rates and a lack of intent-to-treat data for subjects who may not have been as successful with weight loss (Douketis et al., 2005, Stubbs et al., 2011, Fulton et al., 2001). There have been very few long-term studies in youth and of those, the focus has been on 6-12 year olds (Epstein et al., 1994). Indications from the literature suggest that there is better maintenance of weight loss in youth than observed in adults which supports the importance of early intervention (Fulton et al., 2001). Behaviours like reduced television viewing and regular consumption of breakfast have been linked to weight maintenance, as has maintaining meaningful contact with clinicians involved in treatment (Turk et al., 2009, Elfhag and Rossner, 2005). There is still limited evidence on how to best encourage maintenance of healthy lifestyle changes in adolescents.
3.1.3 Previous qualitative research

Qualitative research exploring the barriers and enablers to complex health interventions can provide a better evidence base to inform practitioners and policy makers about what is needed to achieve successful interventions (Oude Luttikhuis et al., 2009, Craig et al., 2008). A recent report (Centre for Physical Activity and Nutrition Research, 2012) identified a number of strategies for recruitment and retention to general community based healthy lifestyle programs. These included encouraging positive word of mouth, fostering strong links with community groups and distributing printed materials in a range of ways including within school newsletters, targeted mail-outs and posting in community venues. However, the report also identified that different strategies may be needed for different population groups. The opinions of local community members, past and potential weight management or healthy lifestyle program participants and interested stakeholders, are thus likely to be useful in developing an understanding of what might and might not work for interventions targeting adolescents who are overweight.

3.1.4 Aims

In this study, focus groups and semi-structured interviews were conducted with adolescents, parents and community stakeholders to provide rich insights into the experiences and perceptions of these groups. The aim of the study was to investigate the perceptions of adolescents, parents and stakeholders regarding barriers and facilitators to recruitment, retention and maintenance associated with a healthy lifestyle program. The insight into specific contextual opinions from the local community can be used to inform the delivery of healthy lifestyle programs for overweight adolescents, with a focus on maximising acceptability and feasibility.

3.2 Methods

3.2.1 Participants

Participants for the current study were recruited from families who had completed the university-based pilot trial of Curtin University’s Activity, Food and Attitudes Program (CAFAP), potential CAFAP participant families and community stakeholders. The university-based CAFAP was an 8-week healthy lifestyle program for adolescents and their parents and was run as a pilot program during school
terms in 2009 and 2010 in Perth, Western Australia (Straker et al., 2010). The research team adapted a successful adolescent obesity tertiary hospital program (Princess Margaret Hospital ‘Fitmatters’ program) and delivered it within a university community context. The program was run by a dietitian, physiotherapist and psychologist and focussed on development of healthy lifestyle behaviours. The adaption was based on the available evidence (Oude Luttikhuis et al., 2009) and informed by the research group’s professional experience. The participants in this pilot program were female (n=22) and male (n=8), obese (BMI percentile mean 96) and aged between 12 and 16 years.

3.2.1.1 Inclusion criteria

In this study, past participant inclusion criteria was an adolescent aged 12-16 years with a previous attendance of at least 6 CAFAP sessions and a BMI-for-age greater than the 85th percentile (Cole et al., 2000) when they entered the program, or the parent of such an adolescent. Potential participant inclusion criteria was an adolescent aged 12-16 years, or the parent of an adolescents aged 12-16 residing in Western Australia. Stakeholder inclusion criteria included adults working with youth, childhood obesity or related community services.

3.2.1.2 Recruitment

Potential participant inclusion criteria was an adolescent aged 12-16 years, or the parent of an adolescents aged 12-16 residing in Western Australia. All families who had completed CAFAP (n=30) were invited to participate and we aimed to recruit 7 adolescents and 7 parents. Adolescents and their parents/carers were initially offered a written invitation to attend focus groups, and follow-up emails and telephone calls were used to maximise attendance, along with a voucher incentive. Participants were given the option of completing a survey electronically if unable to attend a focus group due to timing or transport issues. Separate focus groups for adolescents and parents were planned to encourage open discussion. Past participants were invited to participate to provide a range of opinions based on their experience of a healthy lifestyle program.
Potential participants who had not been influenced by previous involvement in a healthy lifestyle program were invited to participate to provide a range of opinions based on their naïve perceptions of such a program. Recruitment was by referral from General Practitioners, school nurses, and other health professionals, as well as advertisement through community newspapers, school newsletters and radio. As for past participants, separate groups were planned for adolescents and parents. We aimed to recruit 24 adolescents and 24 parents.

Stakeholders with an interest in youth, childhood obesity or community services were invited to participate in a one-off interview. Health professionals in Western Australia and researchers from across Australia, as well as community organisation representatives and policy makers from two metropolitan areas and a regional town were approached based on their experience or interest in overweight and obesity during adolescence. The metropolitan areas chosen included areas of low socio-economic status and were the likely sites for a future intervention, thus providing appropriate local context to inform future delivery. Stakeholders were chosen to reflect a range of diverse views from professionals with an interest or experience in adolescent obesity. We aimed to initially interview 12 community stakeholders and based on their recommendations would interview others identified as having useful experience or insight.

3.2.2 Ethics

Ethical approval for this research has been obtained from Curtin University Human Research Ethics Committee (HR105/2011) (see Appendix A). Written informed consent was provided by all participants (see Appendix B and C). This research was conducted in accordance with the Helsinki Declaration of Human Rights.

3.2.3 Focus group and interview content

3.2.3.1 Theoretical basis

The theoretical foundation for this study was based on the Ecological Systems Theory (EST) proposed by Brofenbrenner (1977), which suggests a complex model of interacting factors impacting human development. The application of EST by
Davison and Birch (2001) describes an interplay of risk factors in the development of childhood overweight occurring at a number of ecological levels. In relation to our study, EST offers a framework to consider the context of an adolescent’s life in the realms of familial, school, community and greater social environments. Participants for this study were chosen to reflect each level and thus included adolescents (individual), parents (familial) and stakeholders (from school, community and social environments).

3.2.3.2 Question development

Questions were tailored to each audience to explore three priority areas relating to overweight adolescent healthy lifestyle programs, specifically: recruitment, retention and long-term maintenance. The main questions were developed with input from the multidisciplinary research team, with a number of sub-questions to fully explore barriers and enablers to effective program delivery. Proposed questions were further reviewed by a panel (including health promotion, physical activity, nutrition, psychology, social work, exercise physiology and behaviour expertise). Schedules were trialled and modified accordingly. Copies of the different schedules are provided in Appendix D and E. The schedules were used by facilitators to guide discussion ensuring specific topics were covered, whilst allowing flexibility for free-flowing discussion where appropriate. Prompts were included to assist participants to focus on the issues relating to their own experiences. The issues discussed were designed to elicit information that would be useful for policy makers and health professionals planning to implement healthy lifestyle programs with adolescents. Facilitators had completed formal training with a qualitative research expert (AM) covering focus group conduct prior to involvement in these focus groups.

As per the focus group schedules, the stakeholder interview questions were developed then reviewed by an expert panel until consensus was reached (see Appendix F). The stakeholder interviews were conducted by members of the research team. All interviews were recorded and transcribed verbatim.
3.2.4 Analysis

With permission from participants, each focus group and interview was audio-recorded for accuracy of transcription and analysis. Confidentiality was ensured by not mentioning participant names whilst the audio-recorder was operating. Transcribed data were also de-identified with subject identifiers assigned to each participant. Data analysis was undertaken in stages, with focus groups and interviews dealt with separately. As soon as practicable following each focus group or interview (within 48 hours), responses to the questions were transcribed and initial thematic analysis conducted (Broom, 2005). All focus group data was transcribed verbatim by one author (AM) and interviews transcribed by another author (KS). Content analyses of transcripts were completed by the authors responsible for the transcriptions to ensure consistency of coding. Inductive techniques were used to thematically code identified topics that emerged from the data (Thomas, 2006). The themes were then grouped into categories based around the structure of the three research questions. The themes and assigned categories were then validated by a second member of the research team and reviewed independently by the other authors to validate the themes thus adding to the overall credibility of findings and interpretations (Gliner, 1994). Differences in interpretation were resolved by consensus. The data were triangulated with adolescent, parent and stakeholder interpretations compared (Polgar and Thomas, 1995). Summaries of the interviews were provided to stakeholders to allow member checking (Bailey, 1997). Any modifications were included in the analysis.

Data from focus groups and interviews were amalgamated and the major themes detailed in a report (McManus et al., 2012) using description and quotes from participants to support these findings (Gliner, 1994).

3.3 Results

3.3.1 Participant demographics

Two focus groups were held with parents (n=4) and adolescents (n=4) who had participated in CAFAP, with written feedback provided by one adolescent and four
additional parents who were not able to attend a scheduled focus group. All past participants who responded to the invitation had completed the full 8 week program. Four focus groups involving parents (n=4) and adolescents (n= 13 per group) were conducted with potential participants. A total of 56 adolescents and adults provided feedback to the study, including 13 past participants (n=8 parents, n=5 adolescents) and 43 potential participants (n=4 parents, n=39 adolescents). Adolescents were aged 12-16 years, with females comprising 52% of the sample. Of the parents, 82% were female. The majority of participants were white Australians from middle-low socio-economic areas. Details regarding household characteristics were not further explored. Focus groups typically lasted around 60 minutes.

A total of 26 interviews were conducted with 39 health professionals, local service providers and researcher stakeholders (see Table 3.1). All stakeholders approached agreed to participate and completed the interview, which typically lasted around 60 minutes. Interviews and focus groups were ceased when no new concepts or themes emerged and it was deemed that saturation had been reached.

3.3.2 Key findings
Three major topics were discussed in the focus groups and interviews, to inform the design of more feasible and effective interventions. A summary of key findings are presented in Tables 3.2, 3.3 and 3.4 under these three topics being: 1) recruitment, 2) retention in the program and 3) maintenance of healthy change.

3.3.2.1 Recruitment
Participants identified that recruitment of adolescents and families to a healthy lifestyle program was a critical issue. Participants recognised obesity as a current health problem and identified a need for interventions for overweight and obese adolescents, however, there were many potential barriers identified that may prevent adolescents from accessing these services. Participants suggested that the barriers need to be considered and addressed, where possible, to maximise the success of recruitment in the future.
[Recruitment was] very challenging. It took forever, took about twice as much time as we anticipated. And is the reason why we needed lots and lots of money.
(Researcher)
### Table 3.1 Background of stakeholder participants

<table>
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<th>Interviewed</th>
<th>Profession</th>
<th>Background</th>
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<tr>
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<td></td>
<td></td>
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<td>1 x Community Clinical Nurse Manager</td>
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<td></td>
<td></td>
<td>8 x Community Nurses (School Health)</td>
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<td></td>
<td></td>
<td>2 x Parenting Officers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 x Sport and Recreation representatives</td>
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<td></td>
<td>3 x Local Council</td>
<td>1 x Youth Services Manager</td>
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<tr>
<td>employees</td>
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<tr>
<td></td>
<td></td>
<td>1 x Youth Services Officer</td>
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<tr>
<td></td>
<td></td>
<td>1 x Leisure Centre Manager</td>
</tr>
<tr>
<td>Researchers</td>
<td>9 x Researchers</td>
<td>From New South Wales, Victoria, South Australia and Western Australia</td>
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Table 3.2 Focus group and interview findings on perceptions regarding recruitment to a community-based healthy lifestyle program

<table>
<thead>
<tr>
<th>Recruitment</th>
<th>Barriers</th>
<th>Enablers</th>
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</table>
| *We’ve had a lot of interest but it’s getting those families to actually register...and still wanting to attend* (Allied Health Professional) | **Adolescents are often embarrassed about having to attend**
- Teenagers often don’t want to go, because they’re very anxious they might see someone they know. Teenagers are already dealing with enormous bullying and other issues; to ask them to do something that they’re concerned may actually make their life worse is going to turn them off the project. (Researcher) | **Advertising needs to sell the message and promote it widely**
- It comes down to selling it really well and selling it as a healthy lifestyle thing, rather than a weight loss group. (Allied Health Professional) |
| **Overweight has become normalised**
- I think they’re in denial a lot of these parents...often the parents are overweight, the kids are overweight, the dog’s overweight, the cat’s overweight. (School Health Nurse) | **Message needs to be positive and not associated with being overweight**
- From a youth development perspective, it’s really important that the young people are interested in doing it, there’s a whole lot of stigma attached to identifying yourself as overweight or obese. (Local Council) |
| **Reluctance to refer and lack of expertise in health professionals**
- Our experience is even paediatricians have had families come to them concerned but the family has been told ‘oh no they’re ok’ when they are clearly overweight, well into the overweight range. (Researcher) | **Program needs to be free**
- The Government should see fit to subsidise something like this alright, ’cause they keep talking about ‘we’ve gotta do something about the obesity of our children’. If they’re not going to put the money forward, then there’s... I mean I work two jobs just to try and make ends meet, I don’t sort of have the extra money to spend on stuff like this.’ (Parent) |
| **Lack of current services**
- The older people in the community are actually well catered for, but younger kids aren’t and I think seriously there is a huge gap because kids are just getting so overweight and they’re not fit. (Allied Health Professional) | **Program needs to be free**
- The Government should see fit to subsidise something like this alright, ’cause they keep talking about ‘we’ve gotta do something about the obesity of our children’. If they’re not going to put the money forward, then there’s... I mean I work two jobs just to try and make ends meet, I don’t sort of have the extra money to spend on stuff like this.’ (Parent) |
| **Broader social barriers**
- The only way you’re going to get them in is if it’s for free. The only way they’re going to keep coming back is if it’s for | **Program needs to be free**
- The Government should see fit to subsidise something like this alright, ’cause they keep talking about ‘we’ve gotta do something about the obesity of our children’. If they’re not going to put the money forward, then there’s... I mean I work two jobs just to try and make ends meet, I don’t sort of have the extra money to spend on stuff like this.’ (Parent) |
free. You’re not going to get a kid in a low socioeconomic family saying yep we’re going to put up the money for this kid [to access a program like CAFAP].

(Local Council)

3.3.2.1 Barriers

3.3.2.1.1 Adolescent embarrassment

Participants highlighted that adolescents can be a difficult group to recruit to healthy lifestyle programs for different reasons. For some adolescents, the fear of humiliation or bullying can make seeking help confronting, and for others, the promotion of a healthy lifestyle was not enticing if they weren’t overly concerned about their weight. In most cases, participants suggested that adolescent views regarding healthy lifestyle programs would be a barrier in itself.

I don’t think that adolescents would like to admit that they’re overweight. (Male Adolescent) Yeah. The reputation of having to go there [the program] and stuff. (Female Adolescent)

I don’t think that you should believe that young people will see those advertisements and say this is something I want to do. Even if it is something they want to do, they’re probably unlikely to say it. (Researcher)

3.3.2.1.2 Overweight has become normalised

It was identified that most parents don’t recognise if their adolescent is overweight, with overweight being almost normal in today’s society. This was thought to have the potential to reduce parent and adolescent receptivity to the offer of health services.

‘If your family think it’s ok to live like that, like nothing’s happened now, what would happen like three years later. And also if they’re already used to the fact that they’re obese, if they see someone suffering, say, going to the gym, and if their daughter or son’s getting stressed out from the exercise, they’ll think ‘oh, you’re ok being obese, let’s not do it’. (Adolescent)
Fundamentally in the general population, it’s not recognised as being a problem [that requires] something to be done about. (Researcher)

3.3.2.1.3 Reluctance to refer and lack of expertise in health professionals

A hesitance to identify overweight and obesity by health professionals was raised. A number of health professionals identified the sensitive nature of obesity as a barrier to referral. A number of researchers identified other issues with health professionals not being able to measure children and adolescents to correctly identify overweight and obesity.

It’s a very sensitive issue. GPs said it is a really difficult thing to raise with parents if they haven’t raised it with you... They don’t want to jeopardise the relationship. (Researcher)

We wanted overweight and mildly obese young people... but we were being sent overly obese young people because these were the ones they saw... GPs don’t have a good way of assessing it... They don’t measure height and weight. GPs don’t know how to talk about it and paediatricians shy away from it. (Researcher)

3.3.2.1.4 Lack of community support services

The hesitancy of health professional referrals was reinforced by a lack of current community services. Researchers identified that new programs often struggled initially with attracting participants, particularly if there was no current referral base.

Up until now we haven’t really targeted obese kids because if we did, we had nowhere to go with it. OK we identify them but now what? (School Health Nurse)

I was looking for other things, particularly as she’s getting older and [dropping], tending to want to drop out of team sports and things like that or out of some of the programs at school that were keeping her very active. There’s nothing out there... Most gyms don’t even take them until they’re 15. (Parent)
3.3.2.1.5  **Social issues**

Participants also identified that families often had a lot of social issues to contend with including: busy schedules, family problems, poor budgeting skills, a lack of healthy food preparation skills and other financial restrictions. It was expressed that often, healthy lifestyles were not a priority for these families.

> *It’s usually things are happening with social determinants or things are happening at home, yeah they’d like to eat healthy but Mum’s only got $20 for the rest of the fortnight and that kind of takes precedence.*  
> *(School Health Nurse)*

### 3.3.2.1.2  **Enablers**

#### 3.3.2.1.2.1  **Extensive advertising**

Participants recommended a wide-reaching and personalised advertising campaign to reach adolescents and parents. There was an emphasis on ‘selling the message’.

> *Face-to-face selling things goes a long way as well. It’s easy to put a brochure at the bottom of a school bag but if you actually talk to people and engage them…we can try and sell it.*  
> *(Allied Health Professional)*

> *Just generalised feedback about the whole group and what’s come out of it… If I see that someone I’ve referred has got something out of it, then [I’ll] definitely keep referring.*  
> *(Allied Health Professional)*

#### 3.3.2.1.2.2  **Avoid stigma of overweight**

Promoting a positive message and trying to avoid embarrassing weight connotations were highlighted as important recruitment strategies.

> *[Do] anything you can to avoid the stigma of this being a project for overweight and obese.*  
> *(Researcher)*

> *If you promote it to help out their sport and improve their performance in that. Those sort of angles might be a good way.*  
> *(Allied Health Professional)*
Say ‘we’re about a lifestyle change’, not a diet, ‘cause that’s what you need to do, actually, a lifestyle change, otherwise you’re just gonna yo-yo for your whole life. Like feeling healthier, more than looking healthier. And feeling better within yourself.’ (Parent)

3.3.2.1.2.3 Make the program accessible

Making a healthy lifestyle program available and accessible for all community members was an identified as an important enabler for recruiting adolescents and families. Participants recommended making the program free or very low cost to increase interest.

So you’re not forced to drop out for lack of money. (Adolescent)

Other parents suggested that making the program free would encourage attendance by families who weren’t totally committed to the program.

I think it was made free too, you might get people who might not really wanna be there for the right reasons, and it might be a bit too overcrowded. (Parent)

3.3.2.2 Retention

Participants described a need for healthy lifestyle programs to employ strategies to keep families engaged and interested, to help prevent drop out. Most researchers in particular had experienced the difficulties of keeping participants motivated to attend.

Following the initial sessions, attendance really dwindled, and sometimes yeah we had only one person. (Researcher)
Table 3.3 Focus group and interview findings on perceptions regarding retention in a community-based healthy lifestyle program

<table>
<thead>
<tr>
<th>Retention</th>
<th>Good experience for adolescents</th>
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<tbody>
<tr>
<td>Most studies have real trouble getting the parents engaged and keeping them interested over time. (Researcher)</td>
<td>I think anticipate that in any weight loss program, which is going to take months or years, people may well come in and out of it... If they see it is a good experience, if they see their teens happy, that’s probably something that’s going to really engage families. (Researcher)</td>
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<table>
<thead>
<tr>
<th>Barriers</th>
<th>Enablers</th>
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<tbody>
<tr>
<td>Location</td>
<td></td>
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<tr>
<td>• I think it’s great if it can be more local, because I have broached it with some other parents before but either transport’s an issue or in trying to get off work and then get there after school, it’s a big ask. (School Health Nurse)</td>
<td></td>
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<tr>
<td>Timing</td>
<td></td>
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<tr>
<td>• Finding the time that actually works is very challenging. And it’s a barrier. (Researcher)</td>
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<tr>
<td>Commitment</td>
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<tr>
<td>• The initial month or two is the hard part, because they’re going from nothing to exercising and always those first couple of months are hard. It’s hard for anyone. (Allied Health Professional)</td>
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<tr>
<td>Social barriers</td>
<td></td>
</tr>
<tr>
<td>• If you feel alone going there, that’s really bad. (Female Adolescent, Focus Group)</td>
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<tr>
<td>Good experience for adolescents</td>
<td></td>
</tr>
<tr>
<td>• I think anticipate that in any weight loss program, which is going to take months or years, people may well come in and out of it... If they see it is a good experience, if they see their teens happy, that’s probably something that’s going to really engage families. (Researcher)</td>
<td></td>
</tr>
<tr>
<td>Fun and practical</td>
<td></td>
</tr>
<tr>
<td>• It had to be fun, especially the adolescent sessions. It had to include fun, active games. They tended to bond more if you included those and when you look at the satisfaction questionnaires, they wanted more activity, as much activity as possible. (Researcher)</td>
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<tr>
<td>Family involvement</td>
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<tr>
<td>• Involving the family, is probably the most important thing that I see. Because it’s got to be a whole family change. Even if the particular teenager wants to do something, if the family’s not supporting that then it’s not going to go anywhere. (Allied Health Professional)</td>
<td></td>
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<tr>
<td>Use online components</td>
<td></td>
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<tr>
<td>• Using electronic media too, that sort of validates it, if they’re getting reminders on their email or on their Facebook... even text messages. Maybe some online self-assessments- if they have something that they can go in and do their own little checklist and they get something back that says ‘oh you’re doing this now’ and prints some little graph for them about how they’re going. (Health Promotion Officer)</td>
<td></td>
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<tr>
<td>Good facilitators</td>
<td></td>
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<tr>
<td>• It’s really important about the people that you employ...as much as it’s about their proficiency and level of organisation, is</td>
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how they interact, you almost need those social skills, they’re so important. (Researcher)

**Goal setting skills**

- *One of the key aspects of goal setting is to make the goals realistic and achievable but also measureable. So that as they’re going along you can together assess whether in fact those goals are at any chance of being reached...because people want to be at the end. So if you can show them that they’ve had three steps forward and two steps back...but can still show them that they’ve made progress. That helps people stay engaged and have a sense of hope for change.* (Psychologist)

**Easy and rewarding for parents**

- *If the parent was coming along to that, the parent has got to get something out of it as well. That could be the exercise and all the same sort of things that you’re trying to do for the child.* (Health Promotion Officer)

### 3.3.2.2.1 Barriers

#### 3.3.2.2.1.1 Location

The location and ease of access for participants was highlighted as important potential barriers for families to stay engaged with a program.

*For many families that is a commitment, in our rather time poor community, that is quite difficult. And that’s why, presumably, success is partly due to having a site of study where it’s easy to get to.* (Researcher)

#### 3.3.2.2.1.2 Timing

Another program-specific factor of start and finish times was identified as a barrier that may make it difficult for some families to stay engaged. Participants were conflicted in their view for the most appropriate start time, wanting to include adolescents immediately after school, but noting that parents are often not available at this time with work and family commitments.
So many parents, if not full time, are working part time... People struggle to pick up their kids from school and get there. (Researcher)

3.3.2.2.1.3 Family commitment

Stakeholders were quick to acknowledge that attending an ongoing healthy lifestyle program and making healthy lifestyle changes were difficult things to do. They noted that the program needed to be a priority for the family and facilitators would have to work hard to try and keep families motivated.

Bigger the body mass, the bigger the resistance to change- partly through a sense of being overwhelmed. Like how am I ever going to be a size 10 if I’m a size 24. If I can’t be a size 10 then I’m not going to bother. (Allied Health Professional)

This is difficult and emphasising that this hasn’t happened overnight and it isn’t going to go away overnight. You need to commit as a family and so we emphasise that family thing. (Researcher)

3.3.2.2.1.4 Social barriers

Participants identified that the environment we live in makes it difficult to stay engaged and make healthy changes.

McDonalds has come out with an ad for under $5 they can get a burger and this and that and the other. You’ve got the convenience and low cost of high salt, high fat junk food. How do you get healthy food choices that are cost effective, easy to prepare and that they’re interested in, when there’s all the attractiveness of this junk food. (Health Promotion Officer)

3.3.2.2.2 Enablers

3.3.2.2.2.1 Must be a good experience for adolescents

Stakeholders recommended focussing on making the program enjoyable and rewarding for adolescents to increase the chance that the family would remain in the program.
Would be great to train with someone else in the group. Random assignment would mean you meet more people. [You] could ‘tag-team’ one exercise until you can’t go anymore. (Adolescent)

Just a group type session, particularly teenagers- they’re one of those groups, and if you get together and they’ve all got similar problems then it’s a lot easier for them to work through those problems and come up with solutions... It’s really hard when they’re on their own, if they feel like they’re on their own. (Allied Health Professional)

3.3.2.2.2 Fun and practical

There were suggestions for the program content, such as using activities that are fun and active, as well as providing practical skills like cooking.

I think once they get engaged and see that it’s practical, then they’ll be fine...and when it gets a name for itself and they can see changes in other teenagers. (School Health Nurse)

It was really very easy to knock up snacks and do stuff that was appropriate for teenagers. And I still maintain that you can eat healthily at a reasonable price, I like [this kind of program] as adapted to a teenage market, not for a mum and a couple of kids. (School Health Nurse)

3.3.2.2.3 Family involvement

The importance of including the whole family was highlighted by all focus group participants, even by the adolescents themselves.

Cause it’s also a lot about the parents. You need to get the parent involved because, like you said, they’re in control of the food and, like, the computer playing and stuff. So basically you have to talk to the parent I guess, and then make them see what they’re doing to their child- they have to do this. (Adolescent)
### 3.3.2.2.4 Good facilitators

Participants described program staff as one of the key enablers for keeping families engaged in a program. Passionate, interested and motivated facilitators were seen to increase the engagement of parents and adolescents in the program. Researchers described the development of a good relationship between facilitator and participant as one of the most critical aspects of the program.

*I think the only thing that would really stop somebody would be a huge personality conflict, right, with the kids with the trainers, instructors, whoever is running it, ‘cause if the child doesn’t like the person, they’re not gonna sit there and listen.’* (Parent)

*Certainly how well a group runs and how well it all goes does depend on the facilitator and the relationship they build.* (Researcher)

### 3.3.2.2.5 Goal setting skills

The use of goal setting during programs was discussed as a good way for adolescents and parents to make small changes and see the progress they make.

*I think goal setting is really important because people can get confused and they can get overloaded. And so it’s the sort of standard suggestions that are made in CBT and other things, you pick a goal that’s achievable. You pick a goal that somebody will understand. You look at pathways to achieve that goal. It is important to let teens personalise things... it should be simple and attempting the goal is praised in some way.* (Researcher)

### 3.3.2.2.6 Easy and rewarding for parents

To account for the effort required to stay engaged in a program, participants recommended making it as easy as possible for families to attend and rewarding their attendance with incentives or teaching them new and practical skills.

*With disadvantaged families in particular, those kind of altruistic ‘your life’s going to wonderful if you do this’, isn’t going to get them there. You’ve got to have practical things like we’re going to give you a gift card or you’re going*
to get a shopping voucher...That’s actually the kind of thing you’re going to need with disadvantaged parents. (Health Promotion Officer)

3.3.2.3 Maintenance

Participants unanimously agreed that maintaining healthy behaviour changes after being involved in a healthy lifestyle program was difficult and required a lot of motivation and commitment from families. It was acknowledged that for adolescents, ways to encourage sustainable change is lacking good evidence and there is still plenty of work to be done in identifying enablers in this maintenance period.

_We know little about, except for some work from the States from the obesity register of why adults keep the weight off, we really don’t know what happens in adolescents._ (Researcher)
Table 3.4. Focus group and interview findings on perceptions regarding maintenance in a community-based healthy lifestyle program

<table>
<thead>
<tr>
<th>Maintenance of healthy change</th>
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</thead>
<tbody>
<tr>
<td><em>Keeping them on track is really helpful, not just to go away and they forget all about it.</em></td>
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<td>(Researcher)</td>
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<table>
<thead>
<tr>
<th>Barriers</th>
<th>Enablers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Difficulty in sustaining change and keeping links to the program</strong></td>
<td><strong>Follow up</strong></td>
</tr>
<tr>
<td>• <em>The feedback from the kids and the parents is that they miss the regular contact and regular check in. I’ve had families specifically ring and say after a few weeks, ‘It’s not going well. I can’t do this and I need some support.’</em> It’s like they need to set some goals and have someone else sit down with them and set some goals to keep going. (Researcher)</td>
<td></td>
</tr>
<tr>
<td><strong>Lack of services to support change</strong></td>
<td><strong>Positive changes are highlighted</strong></td>
</tr>
<tr>
<td>• <em>There’s a lack of centres or activities for kids who don’t want to be into sport, who may want to do something not as physical but with some physicality, but not in team sports.</em> (School Health Manager)</td>
<td></td>
</tr>
<tr>
<td><strong>Online/ electronic media</strong></td>
<td><strong>Transition into community</strong></td>
</tr>
<tr>
<td>• <em>I think text. All kids have phones, most parents have got phones. That’s what they hang off.</em> (School Health Nurse)</td>
<td></td>
</tr>
<tr>
<td>• <em>Ways of linking them into community facilities as you kind of wean the program off. Looking at what’s available for them...So they’re exposed or it’s identified to them what opportunities are available in their environment so that there’s that potential for carry on.</em> (Researcher)</td>
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### 3.3.2.3.1 Barriers

#### 3.3.2.3.1.1 Difficulty in sustaining change

The difficulty in sustaining healthy changes, especially in the context of other family issues was noted by stakeholders. Researchers in particular identified that it was difficult to organise convenient times or interesting activities to encourage
adolescents to come back to review or booster sessions to keep up the support from the program.

Some families go great guns, you know they’ll keep going with things. I guess that’s when there’s no conflict, no social issues and the kid’s really motivated...but there’s some families that you probably know, because of the kid or the parent or both, they’re going to fall in a heap. (Psychologist)

One thing is, as the adolescents got older they ended up getting part-time jobs, or they had greater study commitments, so I think that’s one reason why attendance tapered off in the booster sessions. (Researcher)

3.3.2.3.1.2 Lack of services to support change

Participants identified a lack of supportive services in the community to encourage overweight adolescents to maintain healthy changes. They noted that these adolescents were unlikely to re-engage in team sports but there are few activities available in the community for them to access instead.

We struggle when families get to the end of those twelve months and they want more support, there’s not really anything to refer them onto. (Researcher)

My daughter’s doing Year 8, she’s doing home economics. Guess what they’re cooking? Chocolate cake, simple as that. I mean, it’s nice to have, but they’re not taught that it’s nice to have a little bit, yes, and once in a blue moon it’s ok; but they don’t, they sit there and they have it for morning tea, chocolate cake. (Parent)

3.3.2.3.2 Enablers

3.3.2.3.2.1 Follow-up

A number of factors were suggested by participants that could facilitate maintenance of healthy lifestyle changes. An ongoing link to facilitators or program staff was identified as a potential enabler after the program has finished.
We use things like postcards at Christmas time...maybe here’s some things to think about at Christmas. Trying to get that connection. (Researcher)

An email or check in point where a couple of months down the track...they send a coordinator a message saying these were my goals and this is what I’m doing. Just to sort of make them still take ownership of those goals that they’ve set. (Allied Health Professional)

3.3.2.3.2.2 Focus on positive changes

Participants highlighted the importance of adolescents and parents feeling like they were capable of achieving their own healthy change and having these positive changes recognised by themselves and others when they occurred.

They’ve got to have buy in. And it’s absolutely essential that the parents are involved in it if you want to change things. And you want them to have seen changes...and believe they can do it. (Researcher)

3.3.2.3.2.3 Online/social media component

Communicating with adolescents using their preferred means of contact, particularly by text message and online communication, was highlighted as a good way to encourage maintenance of healthy change.

IT- It’s a cheap, simple and effective way of maintaining engagement. (Psychologist)

I think we really need to explore all of those forms of e-communication that young people do, and just use them as much as we can because they’re forever SMS-ing and Facebooking and so on. And we just need to be using that as part of our ongoing ways of connecting to them. And the dose we were thinking is just way too small. (Researcher)

3.3.2.3.2.4 Transition into the community

Participants agreed that transitioning adolescents into local services and groups after the programs was an important part of maintenance. They were able to
identify some local services that may be accessed to provide opportunities for encouraging kids to stay active (e.g., sporting clubs) and mentally well (e.g., youth services) but highlighted the need for alternative options for adolescents who didn’t enjoy sport.

*I think the kids at 12-16 that aren’t involved in sport; I’d dare to say they’re probably not going to be interested in sport in the future. So you probably need to think maybe like the nature play type activities, the trail bike riding or the bushwalking or canoeing or those sort of sports.* (Local Council)

*Some kids just don’t like sport... It’s trying to educate them on what they enjoy doing. Sometimes you might do things at home so they can set up a little system at home or an aerobics video- lots of videos and things out there now.* (Allied Health Professional)

### 3.4 Discussion

#### 3.4.1 Emerging themes

Past CAFAP participants, future potential CAFAP participants and community stakeholders involved in supporting health interventions articulated a rich description of possible barriers and enablers to recruit and retain future adolescent healthy lifestyle program participants. They also discussed possible enablers for overweight adolescents to maintain a healthy lifestyle after the completion of a program like CAFAP. Some ideas were consistent across informants and supported by existing literature, whilst other emergent ideas and opinions differed between groups and participants.

#### 3.4.1.1 Avoid stigma and make it positive

A strong theme emerged regarding the need for a positive awareness-raising campaign to encourage recruitment. The stigma associated with being overweight or obese was identified as a major barrier by all participant groups, and potentially prevented adolescents looking for help. This is consistent with the literature suggesting overweight adolescents are at greater risk of social isolation and
depression (Merten et al., 2008, Strauss, 2000). This also highlights a need to steer away from labelling adolescents as overweight or obese and labelling programs as weight-related interventions; toward healthy lifestyle or skill-based programs.

3.4.1.2 Spread the word

There were a number of other strategies to improve recruitment highlighted by all groups interviewed in line with current literature, including the importance of advertising the program widely (Nguyen et al., 2012a, Centre for Physical Activity and Nutrition Research, 2012), particularly on the internet, and the need for strong links with health professionals (Centre for Physical Activity and Nutrition Research, 2012), particularly General Practitioners (GPs), to inform them of the program and ways to discuss it with parents and adolescents. Stakeholders indicated that they felt GPs and other health professionals were hesitant to raise the subject with parents or adolescents, most often due to a lack of referral options or lack of training to effectively manage these patients. This is consistent with existing literature (Wake et al., 2013, Perrin et al., 2005).

3.4.1.3 Easy and engaging

An important theme relating to keeping adolescents and parents engaged in the program was to make it accessible and enjoyable for participants. The importance of a local venue and a convenient time was emphasised by all groups interviewed, supported by Brennan et al. (Brennan et al., 2012) who found that non-completers of an adolescent weight management program were more likely to drop out if: there were travel or transportation difficulties; it took too long to get to the sessions; or if work schedules interfered with the timing. A need for passionate and engaging facilitators was raised, with recent literature suggesting that community organisations should recruit appropriately skilled program leaders to maximise retention (Centre for Physical Activity and Nutrition Research, 2012). Participants agreed that the program needed to be fun for all attendees, with a focus on practical activities to keep adolescents and parents engaged; a concept well supported in the literature (Woolford et al., 2012, Alberga et al., 2013). Whilst not specifically asked, participants did not question the desirability of having both
3.4.1.4 Adolescent buy-in

All groups raised the issue of difficulties committing to healthy lifestyle changes and suggested that adolescent ‘buy in’ was critical. Maintenance of healthy lifestyle behaviours are often associated with motivation fostered during the process of attaining goal-related behaviours (Shilts et al., 2004a), and requires one to be committed to the goal for behaviour change to ensue (Locke and Latham, 1990). Previous qualitative work with obese adolescents suggests that they become less motivated within a short period of time (Lindelof et al., 2010) and that emphasis needs to be placed on addressing underlying factors for excess weight gain and setting realistic goals for change. Adolescents’ autonomous motivation, or their sense of volition and enjoyment regarding behaviour engagement, has consistently predicted sustained engagement in healthy lifestyle behaviours (Chatzisarantis and Hagger, 2009) and capitalising on this may help to keep adolescents engaged in healthy behaviours. This idea has been incorporated into the goal setting structure to use with obese adolescent in the refinement of our healthy lifestyle program (Fenner et al., 2013).

3.4.1.5 Lack of services

A strong theme emerged regarding the lack of local, accessible, affordable and enjoyable physical activity options for adolescents in the community to support maintenance of healthy behaviour change following a healthy lifestyle program. This presents a significant barrier for adolescents who may have the skills and motivation to change but are restricted in their environment. This fits with the proposed Ecological Systems Theory Model of predictors of childhood overweight (Davison and Birch, 2001), where low availability of recreation facilities and safe places to be active have a negative impact on children’s activity levels, and hence their health and weight (Davison and Birch, 2001). More research is needed to understand preferred physical activity options for overweight adolescents, with
adolescent studies suggesting non-formal exercise like cycling or walking, which
does not require a high level of skill (Lindelof et al., 2010).

3.4.1.6 Cost issues had different views

Opinions differed regarding the cost for families to attend a healthy lifestyle
program, with some parents and stakeholders suggesting a small monetary fee
would encourage more ‘dedicated’ attendees and help people to place more value
on the program. Other stakeholders and parents indicated that parents would be
put off attending if there was a cost associated with the program and these differing
opinions are highlighted in two reports of stakeholder views (Centre for Physical

3.4.1.7 Parent motivation

Common barriers for parents of adolescents who dropped out of a recent lifestyle
intervention included a lack of interest/motivation and lack of time available to
participate (Brennan et al., 2012). Parents involved in the focus groups described
high levels of motivation which may not be reflective of the opinion or intent of all
parents of overweight adolescents and this research should to be interpreted in the
light of participant bias (Hollander, 2004). Previous research with parents of obese
adolescents suggests high levels of concern for their adolescent’s well-being but
often a sense of helplessness with how to work with their adolescent (Boutelle et
al., 2012). This study confirms parent concern but further insights are limited by
small group numbers.

3.4.2 Limitations

There were a number of limitations with this study. Firstly, difficulties with
recruitment resulted in fewer adolescent and parent participants than planned.
However, an absence of new topics emerging from the final transcriptions
suggested saturation had been reached for parents and adolescents as well as
stakeholders. This research explored the opinions of adolescents, parents and
stakeholders in low-middle socio-economic regions of Western Australia and thus
results need to be taken in context. We had some minority ethnic groups
represented but no indigenous participants in the focus groups, so findings cannot necessarily be generalised to different communities. The views of researchers were open to bias as they were reporting on their experiences with overweight adolescent interventions. However, researchers were only included in the interviews if they had extensive and direct experience in this field, which the authors feel is of high clinical significance. Further, lifestyle interventions may only reach the sub-group of obese adolescents willing and able to attend such programs and thus other interventions such as active desks (Straker et al., 2009) are needed to reach the whole population in need. Despite these limitations, the results from this study are consistent with the current literature regarding recruitment and retention for community-based programs (Straker et al., 2012).

3.4.3 Strengths

The strengths of this study include consultation with, and direct input from adolescents, their parents and key stakeholders around the prevention and/or management of adolescent overweight and obesity. Trained facilitators led the discussions and the homogenous groupings permitted honest and open discussion in a supportive environment. The discussion schedules were based on a sound theoretical framework with questions tailored to explore individual, familial and broader societal factors associated with adolescent obesity. Other strengths of this study were consultation with a wide range of informants with relevant experience in the area, and the collection of in-depth information about the challenges associated with the implementation and evaluation of interventions for overweight adolescents by examining the whole spectrum of recruitment, retention and maintenance.

Despite accumulating research into perceptions of adolescents, parents and stakeholders regarding the causes of overweight and suggested management strategies; there has been limited evidence to inform the actual implementation of a community-based healthy lifestyle program. This study makes unique a contribution to the evidence base by describing the barriers and enablers to implementing a successful healthy lifestyle program for overweight adolescents as
perceived by families and community stakeholders. This understanding will be useful to improve acceptance, attendance and completion of programs thus improve their feasibility within a community setting.

3.4.4 Implications for practice and research

Based on the valuable information provided by past participants, potential participants and stakeholders, a number of recommendations are made to maximise the effectiveness of a family-centred, community-based intervention for overweight adolescents. These recommendations have already guided the protocol for one such program (Straker et al., 2012).

3.4.4.1 Recruitment

Recruitment is one of the most difficult parts of any lifestyle program. Researchers and health professionals need to utilise a number of strategic marketing approaches to attract parent and adolescent interest including: online advertising and web-based information; advertising in newspapers and on radio; repeated exposure; and development of links with schools and health professionals (Centre for Physical Activity and Nutrition Research, 2012). Potential barriers to engaging in a healthy lifestyle program also need to be identified, considered and minimised within each community where possible, particularly regarding location, timing (both days of the week and start/finish times) and cost.

3.4.4.2 Retention

To retain families and keep them engaged with a healthy lifestyle program, facilitators need to be passionate and engaged themselves, with time and focus given to fostering relationships with both adolescents and parents. This sense of belonging and opportunity to share similar problems plays an important role in a successful group. Adolescents also need to have opportunities to make choices about what they do and provide feedback about the program. The sessions need to be fun, with a positive focus on practical activities. Goal setting based on these factors also plays an important role to help participants work towards realistic and achievable goals, whilst having the potential to demonstrate progress and promote
autonomous motivation. The activity component of the sessions should be fun, with a number of activities that adolescents may not have done before and may be interested in continuing with once the program has finished. Ultimately, parents and adolescents need to feel that the program meets their needs, with content relevant and useful for the families who attend.

### 3.4.4.3 Maintenance

There has been little research into maintenance of healthy behaviours after adolescent participation in a healthy lifestyle program. This study found that to maintain ongoing positive change, follow up contact needs to be regular and appropriate to assist with goals set during the program. Participants should stay linked to the program after it has concluded and programs may need to explore online support as a strategy to do this. Setting up a website with recipes, tips for exercise, goal setting activities, and testimonials from former participants could keep families engaged with the healthy lifestyle changes and an ability to interact with other participants, for example through a blog or social network site, would provide networking opportunities for both parents and adolescents. Special attention should be given to developing multi-media strategies to suit adolescents. Maintenance of healthy changes after program conclusion could be supported further by linking adolescents with existing community services that promote being active, eating healthily or engaging in community activities. This should be promoted during the program and adolescents could choose activities or programs they enjoy. Overweight adolescents may be reluctant to re-engage in organised sport, so other options like cycling or fitness classes should be encouraged.

### 3.4.4.4 Assessment burden

Assessment burden needs to be minimised or compensated for where possible. It should be recognised that lengthy or invasive assessments have the potential to dissuade participants from staying engaged in an intervention program. Assessments need to be kept as short as possible, only measure the specific outcomes associated with the program and be completed at a local site that can be easily accessed by participants. Compensation or incentives for completing
assessments may need to be provided if the burden cannot be minimised sufficiently.

### 3.5 Conclusions

Being overweight in adolescence is a major problem; however, limited evidence is available regarding effective and appealing intervention programs for overweight adolescents. Previous studies note difficulties with recruitment or high drop-out rates, however, there is limited evidence identifying specific barriers and enablers to engaging overweight adolescents in a healthy lifestyle program, how to keep them engaged and how to maintain healthy behaviour changes post intervention. This study outlines a number of key barriers to recruiting adolescents and families, and suggests ways to maintain engagement and behaviour change during and following a healthy lifestyle program for overweight adolescents and their families. These findings can be used by researchers to enhance recruitment, retention and maintenance in community-based intervention studies with the target group. The findings can also be used by health service policy makers, planners and service providers to improve feasibility and acceptability of these types of programs and their long-term institutionalisation within community settings.
Chapter 4.0 Study B: Overweight and obese adolescent intake by time of day and day of week

The information in this chapter has been published in the Journal of Human Nutrition and Dietetics as follows:


This chapter includes analysis of overweight adolescent dietary consumption patterns in a group of adolescents entering a healthy lifestyle program. The aim of this study was to examine the timing and consumption of fruit, vegetables and junk food by time of the day and day of the week.

Overweight adolescents (n=61) aged 12-16 years completed 3-day food records. Negative binomial and binary logistic regression using generalised estimating equations were used to compare the amount and likelihood of consumption of each food group between time periods.

This study showed distinct trends in consumption of fruit, vegetables and junk food by time of day and day of week for overweight boys and girls.

Overweight adolescent girls were more likely to eat fruit on weekdays than weekends (OR=5.0, p<.001), as were boys (OR=2.5, p=.034). Adolescents consumed more fruit at school than other meals (girls: IRR=7.5, p<.001; boys: IRR=4.0, p=.050). Weekday dinner was the meal where girls were most likely to consume vegetables (OR=3.0, p=.009) and when boys consumed the most vegetables (IRR=30.9, p=.006). Fast food consumption was most likely for girls at dinner on the weekend (OR=9.6, p=.042) whilst boys’ fast food intake increased overall on the weekend (IRR=3.6, p=.001). Intake of ‘other junk’ (e.g., crisps) peaked during school hours for girls (IRR=7.2, p<.001) and sugar-sweetened
beverage consumption increased for boys on the weekend (IRR = 3.3, p = .001). Overall, trends in fruit intake showed opposing times for high and low consumption when compared to vegetable intake.

These results represent the next step in using time of day and day of week consumption patterns to develop targeted, evidence-based dietary messages for interventions in overweight adolescents.

4.1 Background

4.1.1 Prevalence of adolescent obesity and associated risk factors

It is estimated that around a quarter of adolescents in countries like Australia and the United States of America (USA) are overweight or obese (National Health and Medical Research Council, 2013b, Ogden et al., 2010), possibly as a result of a societal shift in lifestyle habits including a reduction in physical activity levels, increase in sedentary behaviour and increased consumption of energy-dense, nutrient-poor food and larger food portions (Reilly and Kelly, 2011). Trends in the USA show food portions and total energy from eating occasions are increasing in children aged 2 to 18 years (Piernas and Popkin, 2011a). In the adolescent age-group, larger portion sizes and increased kilojoules at eating occasions are mostly from foods such as pizza, sugar-sweetened beverages (SSBs) and French fries (Piernas and Popkin, 2011b). These data suggest that more detailed analysis of eating occasions may have merit and allow for selective targeting of dietary intervention strategies.

4.1.2 Dietary intervention design

Broad guidelines exist for the dietary management of adolescent obesity and include reduced consumption of energy-dense foods and SSBs and increased consumption of fruits and vegetables (National Health and Medical Research Council, 2013b, Barlow, 2007). However, there remains a lack of strong evidence
about the most effective ways to design interventions targeting adolescent obesity due to a limited description of dietary intakes from intervention studies at both baseline and post-intervention (Ho et al., 2012). Dietary records are rarely undertaken in overweight participants, possibly due to the challenges of collecting plausible records (Livingstone et al., 2004). However, the collection of dietary record data is important as it allows for more detailed analysis of eating occasions, timing of eating and the variability in foods eaten from weekdays to weekend days (Thompson and Subar, 2013). This information may be of significance for behavioural intervention research and could inform the basis of targeted messages and intervention strategies to help adolescents set relevant and specific goals, potentially one of the most efficacious ways to promote healthy behaviour change (Locke and Latham, 1990, Shilts et al., 2004a).

4.1.3 Previous evidence

A recently released Australian report describes a typical temporal pattern for female and male adolescent dietary intake but has limited use in intervention planning due to a lack of separation of weekday and weekend intakes and lack of detail for overweight adolescents (Commonwealth Scientific and Industrial Research Organisation, 2012). Further, these data were collected using two 24-hour three-pass dietary recalls, which rely on memory of foods and beverages consumed and the timing of these, as well as appropriate conceptualisation of portion size (Margetts and Nelson, 1997), which may not provide the level of accuracy and detail offered by food records. Other dietary data exists for younger overweight children aged 5-9 years (Burrows et al., 2011, Magarey et al., 2011b), although the applicability to adolescents is limited given the change in patterns of eating observed between childhood and adolescence (Story et al., 2002, Martin et al., 2008).

4.1.4 Aim

Based on this lack of evidence, there is a critical need to understand the dietary intake patterns of overweight adolescents to develop evidence-based interventions. The aim of the current study was to examine the timing and consumption of fruit,
vegetables and junk food by time of the day and day of the week for overweight Australian adolescents entering a healthy lifestyle program.

4.2 Methods

4.2.1 Participants and procedures

Dietary information was collected from 61 overweight and obese adolescents entering the Curtin University Activity, Food and Attitudes Program (CAFAP). CAFAP is described elsewhere (Straker et al., 2012) but in short was a multi-disciplinary, community-based eight week healthy lifestyle program designed for overweight adolescents and their parents. Participant inclusion criteria was adolescents aged 12-16 years, with a BMI-for-age and gender above the 85th percentile on the standard Centers for Disease Control (CDC) charts. Height and weight were measured using standardised protocols with BMI z-scores determined using the CDC online calculator. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human participants were approved by the Curtin University Human Ethics Research Committee (HR105/2011). Written informed consent/assent was obtained from all participants.

4.2.2 Dietary intake measure

Three day food records were used in this study to provide comprehensive information about meal patterns and intake of foods and beverages. Data collection took place between January 2012 and September 2012. Three day food records (two weekdays and one weekend day) using provided household measures were completed by participants to report all food and beverage consumed and the time of consumption. Three days provides a reasonable compromise between understanding the variation in daily adolescent diets (Magarey et al., 2011a) and the risk of poor quality information due to excessive participant burden (Collins et al., 2010). Adolescents were given written and verbal instructions from the research dietitian regarding estimating portion size. The completed record was reviewed by the research dietitian and details were clarified with the adolescent.
4.2.3 Data analysis

The diet records were analysed for specific nutrient intake using the AUSNUT database and Foodworks Professional edition version 3.02 software. Data was extracted for intakes of total energy, macronutrients and percentage contribution to energy intake, as well as select micronutrients. Iron, zinc, calcium and vitamin C were identified as important micronutrients to support growth and development during adolescence and thus were chosen as indicators to reflect nutritional adequacy.

Food records were analysed by a dietitian for the number of serves of fruits and vegetables, determined according to the Australian Guide to Healthy Eating serve sizes (National Health and Medical Research Council, 2013c), and junk food according to published criteria (Rangan et al., 2008, National Health and Medical Research Council, 2013c). The term ‘junk food’ is used to describe ‘discretionary’ foods that are considered energy-dense, nutrient-poor foods (Rangan et al., 2008, Dixon et al., 2007, National Health and Medical Research Council, 2013c). Serves of fruit (150g fresh fruit and 30g dried fruit) were calculated excluding fruit juice, given the difficulty in identifying juice that had been sweetened and the propensity to consume excessive amounts of juice. Serves of vegetables (75g) included all vegetables other than fried potato, which were included in junk food. Serves of junk food (600 kilojoules or 144 calories) (National Health and Medical Research Council, 2013c) were further split into three categories to differentiate between intakes of fast food, SSBs and other junk food, given the specific correlations with obesity (Taveras et al., 2005a, Thompson et al., 2004, Malik et al., 2013, Vartanian et al., 2007). Fast food included energy-dense meals and snacks purchased from fast food restaurants, for example, hamburgers, fried chicken and fried potato chips. Sugar-sweetened beverages included beverages with added sugar (soft drink, energy drinks, sports drinks, cordial and fruit juice drink). Flavoured milks were classified as core foods and not included in the junk food score (Rangan et al., 2008). Other junk food included all other energy-dense, nutrient-poor foods, for example, cake, butter, crisps and confectionary.
Each 24-hour day was split into 5 time categories to track periods of consumption. The time periods were chosen to map against the school day and kept consistent with weekends to allow comparison of the same time period for weekdays and weekend days. The adolescents recorded time of consumption rather than being asked to define the eating occasion as a meal or snack. Time period 1 was breakfast/before school (0500-0859hrs), time period 2 was around lunch/at school (0900-1459hrs), time period 3 was afternoon/after school (1500-1729hrs), time period 4 was around dinner (1730-2129hrs) and time period 5 was late night (2130-0459hrs).

4.2.4 Statistical analysis

Descriptive statistics were calculated for participant characteristics and nutrient and food group intakes. Comparison of consumption of various food groups (namely fruit, vegetables, fast food, SSBs and other junk food) were made between weekend days/weekdays and between the five time periods over a day, using two methods of regression analysis, both employing generalised estimating equations to account for the count nature of the data and within-person correlations in the repeated measures. Firstly, negative binomial regression was used to compare the number of serves of each food group consumed between occasions as proportional differences in serves expressed as incidence rate ratios. Secondly, binary logistic regression was used to compare the odds of consumption of at least half a serve at each time period, as opposed to not consuming that food group at all, expressed as odds ratios. Time periods were excluded from analysis if counts of consumption were zero for a particular food group (i.e. late night consumption of fruit was excluded from analysis because the consumption levels were zero). Time periods with very low consumption levels were merged with the following time period when analysis was not possible (i.e. breakfast consumption of fast food was so small that it was merged with lunch consumption of fast food for analysis.) For models comparing weekdays to weekend days, separate analysis was conducted for boys and girls. For models comparing time periods over the day, separate analysis was conducted for weekdays and weekend days and boys and girls. Estimates for incident rate ratios (IRR) for negative binomial and odds ratios (OR) for logistic regression are presented...
with accompanying 95% confidence intervals and associated p-values. Data analysis was performed using SPSS v.20 (SPSS Inc., Chicago, IL).

4.3 Results

4.3.1 Subjects

Food records booklets were provided to 66 adolescents; five participants withdrew before completing a valid food record. Of the 61 adolescents (20 boys and 41 girls; BMI z-score 2.12 (0.4); see table 4.1) who completed baseline food records, none were excluded for reporting an extremely low intake (<2090 kJ/500 kCal cut-off selected to balance exclusion bias and extreme underreporting error as used by Field (2003)).
Table 4.1 Mean (standard deviation) participant characteristics and nutrient intake in a group of overweight adolescents entering CAFAP

<table>
<thead>
<tr>
<th></th>
<th>Girls n=41</th>
<th>Boys n=20</th>
<th>All n=61</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>14.3 (1.6)</td>
<td>13.3 (1.3)</td>
<td>14.0 (1.6)</td>
</tr>
<tr>
<td><strong>BMI z-score</strong></td>
<td>2.1 (0.4)</td>
<td>2.2 (0.4)</td>
<td>2.1 (0.4)</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Macronutrients</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Energy (kJ)</strong></td>
<td>7652 (2254)</td>
<td>9343 (2482)</td>
<td>8179 (2437)</td>
</tr>
<tr>
<td>(kcal)</td>
<td>1831 (5391)</td>
<td>2235 (594)</td>
<td>1957 (583)</td>
</tr>
<tr>
<td>%energy from protein</td>
<td>16.8 (3.6)</td>
<td>16.7 (4.2)</td>
<td>16.8 (3.8)</td>
</tr>
<tr>
<td>%energy from fat</td>
<td>33.3 (6.3)</td>
<td>35.3 (4.1)</td>
<td>33.9 (5.7)</td>
</tr>
<tr>
<td>%energy from saturated fat</td>
<td>14.1 (3.7)</td>
<td>14.9 (2.3)</td>
<td>14.3 (3.3)</td>
</tr>
<tr>
<td>%energy from carbohydrate</td>
<td>47.0 (6.4)</td>
<td>46.2 (6.6)</td>
<td>46.8 (6.4)</td>
</tr>
<tr>
<td>%energy from sugar</td>
<td>19.8 (6.2)</td>
<td>19.1 (9.9)</td>
<td>19.6 (7.5)</td>
</tr>
<tr>
<td><strong>Fibre (g)</strong></td>
<td>18.2 (6.4)</td>
<td>18.1 (4.7)</td>
<td>18.1 (5.9)</td>
</tr>
<tr>
<td>(g/1000 kJ)</td>
<td>2.4 (0.7)</td>
<td>1.9 (0.4)</td>
<td>2.3 (0.7)</td>
</tr>
</tbody>
</table>

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Micronutrients</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vitamin C (mg)</strong></td>
<td>84.6 (55.6)</td>
<td>57.7 (34.8)</td>
<td>76.2 (51.4)</td>
</tr>
<tr>
<td><strong>Calcium (mg)</strong></td>
<td>659.3 (251.4)</td>
<td>773.1 (376.2)</td>
<td>693.5 (295.7)</td>
</tr>
<tr>
<td><strong>Iron (mg)</strong></td>
<td>10.0 (3.6)</td>
<td>11.96 (3.0)</td>
<td>10.6 (3.5)</td>
</tr>
<tr>
<td><strong>Zinc (mg)</strong></td>
<td>9.19 (3.3)</td>
<td>11.42 (3.3)</td>
<td>9.9 (3.4)</td>
</tr>
</tbody>
</table>

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food groups</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fruit (serves)</strong></td>
<td>0.8 (0.9)</td>
<td>0.5 (0.4)</td>
<td>0.7 (0.8)</td>
</tr>
<tr>
<td><strong>Weekday</strong></td>
<td>1.0 (1.0)</td>
<td>0.6 (0.5)</td>
<td>0.9 (0.9)</td>
</tr>
<tr>
<td><strong>Weekend</strong></td>
<td>0.5 (0.7)</td>
<td>0.2 (0.5)</td>
<td>0.4 (0.7)</td>
</tr>
<tr>
<td><strong>Vegetables (serves)</strong></td>
<td>1.3 (1.3)</td>
<td>1.0 (0.7)</td>
<td>1.2 (1.1)</td>
</tr>
<tr>
<td><strong>Weekday</strong></td>
<td>1.4 (1.4)</td>
<td>1.2 (1.1)</td>
<td>1.3 (1.3)</td>
</tr>
<tr>
<td><strong>Weekend</strong></td>
<td>1.1 (1.4)</td>
<td>0.7 (1.2)</td>
<td>1.0 (1.3)</td>
</tr>
<tr>
<td><strong>Junk food (serves)</strong></td>
<td>4.9 (2.8)</td>
<td>7.6 (4.1)</td>
<td>5.8 (3.5)</td>
</tr>
<tr>
<td><strong>Weekday</strong></td>
<td>4.6 (2.9)</td>
<td>6.6 (4.3)</td>
<td>5.2 (3.5)</td>
</tr>
<tr>
<td><strong>Weekend</strong></td>
<td>5.6 (5.2)</td>
<td>9.5 (6.4)</td>
<td>6.8 (5.9)</td>
</tr>
</tbody>
</table>
4.3.2 Nutrient intake

Table 4.1 summarises nutrient and food group intake for participants. Macronutrient intake as a percentage of energy suggests a moderate to high intake of fat for boys and girls. These results were slightly higher than the national data for percentage of energy provided by fat, although percentage energy provided by protein and carbohydrate were comparable to the most recent national survey (Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008).

The intake of calcium for adolescents entering the CAFAP program was below the Estimated Average Requirements (EAR) of 1050mg for both boys and girls (Table 4.1). For girls, this low intake of calcium is similar to national data (Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008), however boys participating in CAFAP reported a lower intake of calcium than the national boys average. Intake of other micro-nutrients (zinc, iron and vitamin C) met Estimated Average Requirements.

4.3.3 Food groups

Reported consumption of fruit and vegetables for girls and boys was below recommendations of 2 fruit serves (0.7 serves) and 4-5 vegetables serves (1.2 serves) per day. Junk food consumption (5.8 serves) was comparable to the 7.2 serves of junk food consumed by girls and boys in last National Nutrition Survey (Rangan et al., 2008).

4.3.4 Temporal pattern of food group consumption

4.3.4.1 Fruit

The mean intake of fruit and vegetable serves across weekday and weekend days is shown for both sexes in Figure 4.1, and contrasts in intake over weekend versus weekdays are shown in Table 4.2. When analysed for weekday and weekend consumption, girls consumed less fruit on weekends compared to weekdays (mean 1.0 vs 0.5 serves, IRR= 0.4, p<.001) as did boys (mean 0.6 vs 0.2 serves, IRR=0.4, p=.034) with both girls and boys being less likely to consume fruit on a weekend day
(OR= 0.2 and 0.1 respectively, p<.001). Contrasts in fruit intake over time periods during weekdays and weekend days are shown in Table 4.3. On weekdays girls consumed 7.5 times more fruit at school when compared to breakfast (mean 0.1 vs 0.6 serves, p<.001, Table 4.3). Fruit consumption at school was 14.0 times more likely than at breakfast (p<.001, Table 4.1). On the weekend there was no difference in the probability of fruit consumption in different time periods for girls. Boys on a weekday were 6.2 times more likely to consume fruit at school than at breakfast (p=.034, Table 4.3) and to consume 4.0 times as much at school than at breakfast (0.1 vs 0.3 serves, p=.050). There were no other differences observed on a school day, nor were there any differences on a weekend day for boys.

Figure 4.1 Intake (serves) of fruit and vegetables by sex, day of the week and time of day

*Time periods (x axis) represent the following time periods 1: 0500-0859hrs, 2: 0900-1459hrs, 3: 1500-1729hrs, 4: 1730-2129hrs and 5: 2130-0459hrs. Time period 2 on weekdays is during school hours.
Table 4.2 Fruit, vegetable and junk food serves and likelihood of consumption by day for girls and boys

<table>
<thead>
<tr>
<th></th>
<th>Count of serves</th>
<th>At least half a serve (Yes vs No)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>IRR 95% CI</td>
</tr>
<tr>
<td>Fruit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday</td>
<td>1.0</td>
<td>1</td>
</tr>
<tr>
<td>Weekend day</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday</td>
<td>0.6</td>
<td>1</td>
</tr>
<tr>
<td>Weekend day</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Vegetables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday</td>
<td>1.4</td>
<td>1</td>
</tr>
<tr>
<td>Weekend day</td>
<td>1.1</td>
<td>0.8</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday</td>
<td>1.1</td>
<td>1</td>
</tr>
<tr>
<td>Weekend day</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Fast food</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday</td>
<td>0.7</td>
<td>1</td>
</tr>
<tr>
<td>Weekend day</td>
<td>1.1</td>
<td>1.6</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday</td>
<td>1.1</td>
<td>1</td>
</tr>
<tr>
<td>Weekend day</td>
<td>3.7</td>
<td>3.6</td>
</tr>
<tr>
<td>Sugar-sweetened beverages</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday</td>
<td>0.3</td>
<td>1</td>
</tr>
<tr>
<td>Weekend day</td>
<td>0.5</td>
<td>1.8</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday</td>
<td>0.6</td>
<td>1</td>
</tr>
<tr>
<td>Weekend day</td>
<td>2.0</td>
<td>3.3</td>
</tr>
<tr>
<td>Other junk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday</td>
<td>3.6</td>
<td>1</td>
</tr>
<tr>
<td>Weekend day</td>
<td>4.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday</td>
<td>4.9</td>
<td>1</td>
</tr>
<tr>
<td>Weekend day</td>
<td>3.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>

IRR: Incident rate ratios for negative binomial regression
OR: Odds ratios for logistic regression
CI: Confidence Interval
*a Unable to estimate due to quasi-separation of the data
4.3.4.2 Vegetables

There were no significant differences in the amount of vegetables consumed on a weekday or weekend for either sex (Table 4.2). Boys were less likely to consume vegetables at all on a weekend (OR=0.1, p=.002, Table 4.3). For girls on weekdays, the probability of vegetable consumption was 3.0 times higher at dinner than around lunch (p=.009) with girls consuming 2.7 times more at this time (p=.002). Dinner for boys on a weekday was the period of highest vegetable consumption (see Figure 4.1), with consumption at dinner 30.9 times more likely than at school (p=.006) and the amount consumed being 19.0 times more than at school (p=.005, Table 4.3). There were no differences between at school and after school, with breakfast consumption being too low to include in analysis.
Table 4.3 Fruit and vegetable serves and likelihood of consumption by time of day for girls and boys on weekdays and weekend days

<table>
<thead>
<tr>
<th>Count of serves</th>
<th>At least half a serve (Yes vs No)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Mean</td>
</tr>
<tr>
<td>period</td>
<td></td>
</tr>
<tr>
<td>Fruit (compared to time period 1)</td>
<td></td>
</tr>
<tr>
<td><strong>Girls</strong></td>
<td></td>
</tr>
<tr>
<td>Weekdays</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>2</td>
<td>0.6</td>
</tr>
<tr>
<td>3</td>
<td>0.2</td>
</tr>
<tr>
<td>4</td>
<td>0.1</td>
</tr>
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|          | 0.3-2.0  | .562    |

IRR: Incident rate ratios for negative binomial regression
OR: Odds ratios for logistic regression
CI: Confidence Interval

a After school/afternoon vs school/around lunch differences
b Dinner vs school/around lunch differences
c Dinner vs after school/afternoon differences

Note: Time period 5 was excluded from results due to insufficient data
*Time periods with very low levels of consumption were merged with the proceeding time period for analysis
4.3.4.3 Junk food

The mean intake of junk food across weekdays and weekend days for both sexes is shown in Figure 4.2, with breakdown of intake by the three junk food categories (i.e. fast food, SSB and other junk). Contrasts in junk food intake over weekend versus weekday days are shown in Table 4.2, and over time periods during weekdays and weekend days in Table 4.4.

Figure 4.2 Intake (serves) of junk food by sex, day of the week and time of day

---

\(^a\)Time periods (x axis) represent the following time periods 1: 0500-0859hrs, 2: 0900-1459hrs, 3: 1500-1729hrs, 4: 1730-2129hrs and 5: 2130-0459hrs. Time period 2 on weekdays is during school hours.
Table 4.4 Junk food serves and likelihood of consumption by time of day for girls and boys on weekdays and weekend days

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<th>IRR</th>
<th>95% CI</th>
<th>p-value</th>
<th>Time period</th>
<th>Proportion n(%)</th>
<th>OR</th>
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*Values are represented in the table with statistical significance levels indicated by the asterisks: * (p < .05), ** (p < .01), and *** (p < .001).
### Other junk (compared to time period 1)

#### Girls

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#### Weekends

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#### Boys

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#### Weekends

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</tbody>
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**Note:** Time period 5 was only included in the results when there was sufficient data

*Time periods with very low levels of consumption were merged with the proceeding time period for analysis

---

### 4.3.4.3.1 Fast food

For girls fast food consumption did not differ significantly from weekday to weekend, whilst boys intake increased from 1.1 serves on a weekday to 3.7 serves on a weekend day (IRR= 3.6, p=.001, Table 4.2). On weekdays girls’ fast food consumption was not significantly different across the day, nor was the probability of consumption (Table 4.4). Girls consumed very little fast food around lunch on weekends (Figure 4.2) so the amount consumed at dinner on weekends was 14.0 times more and the consumption of fast food was 9.6 times more likely than around
lunch (Table 4.4). On weekdays for boys, the amount of fast food consumed was 8.5 times more at dinner than at school although the probability of consumption of at least half a serve was not different between the time periods. On weekends the amount of fast food consumed by boys was not significantly different across the day, nor was the probability different between lunch, dinner and late night.

4.3.4.3.2 Sugar-sweetened beverages

For girls SSB consumption was generally low and did not differ from weekday to weekend (mean 0.3 vs 0.5 serves, IRR =1.8, p=.082, Table 4.2), whilst boys intake increased from 0.6 serves on a weekday to 2.0 serves on a weekend. For girls, consumption of SSBs did not differ over the weekday. On the weekend, the probability of SSB consumption and the amount consumed was similar around lunch and dinner for girls (Figure 4.2), which was higher than at other times of the day. For boys, there was no difference in the probability or amount consumed on a weekday, although on a weekend the probability of consumption of SSBs was 3.8 times more likely around lunch as compared to dinner (Table 4.4) with 3.6 times more serves being consumed.

4.3.4.3.3 Other junk

Consumption of other junk did not change significantly from a weekday to weekend for either girls (mean 3.6 vs 4.0 serves, IRR= 1.1, p=.505, Table 4.2) or boys. On a weekday, girls consumed 1.6 times more other junk at school than after school (p=.046, Table 4.4). The probability of consumption was 2.8 times more at school than around dinner. On a weekend there were similar trends with girls consuming 1.9 times more other junk around lunch than at dinner with no difference in probability of consumption. For boys on a weekday, there was no difference between the degree of consumption of other junk at dinner and at school or after school. There was no difference in the probability of consumption of other junk across the day, apart from significantly lower odds of consumption at breakfast. On the weekend there were no differences observed in probability or amount consumed across the day for boys.
4.4 Discussion

A key finding of this study was that overweight adolescents’ timing and consumption of fruit, vegetables and junk food varied by time of the day and day of the week and patterns varied for boys and girls. For fruit and vegetables, this allowed for the identification of opportunities to build on current healthy behaviours or times to introduce new behaviours where gaps were evident, such as at breakfast time. For junk food, the identification of periods of high consumption highlighted potential times of day for targeting reduced intake messages, like around main meals on weekends. Empirical and theoretical data regarding determinants of dietary behaviours (Contento, 2011) provide the broad overview for dietary interventions (Smith et al., 2014b). However, to help overweight adolescents set goals for lifestyle change, targeted and relevant dietary messages based on the intake of overweight adolescents may be useful.

Adolescent goal setting during healthy lifestyle programs has not been extensively evaluated (Fenner et al., 2013), however it does seem that adolescent goals are strengthened when made specific (Locke and Latham, 1990, Gao and Podlog, 2012). Action planning is the process of setting goals and defining specific actions for achieving those goals (van Osch et al., 2009). Recent research has shown that action planning significantly predicts healthy behaviour change and can have positive effects on increased consumption of fruit at the same time as reduced consumption of snack foods (van Osch et al., 2009). To incorporate this into adolescent interventions, facilitators may be able to identify high risk times for certain food behaviours and encourage participants to set goals around these patterns. For example, if the adolescent wants to set a goal around healthy eating, the facilitator could use the following sentences to help guide them. “Dinner on the weekend is a highly likely time for adolescents to eat fast food. Would you like to set a goal around this time to keep your healthy eating goals on track?” Similarly, “Breakfast time is normally not when adolescents eat fruit, but could be a good time to start. You could choose to plan to increase your intake of fruit at this time of day.” The use of clear dietary messages may help adolescents to choose specific nutrition-related goals whilst maintaining their sense of autonomy (Shilts et al., 2004a), and thus
increase the likelihood of adoption of healthier behaviours (Nothwehr and Yang, 2007).

4.4.1 Fruit and Vegetables

Fruit and vegetable consumption display opposing trends (Figure 4.1), particularly at lunch where fruit intake is higher but vegetable intake lower, and at dinner where fruit intake is lower but vegetable intake is higher. It is important to consider existing behaviours when identifying opportunities to promote new healthy behaviours, because unintentional displacement of existing health behaviours may result. For example, targeting an increase in vegetable intake at a high fruit consumption time may unintentionally displace consumption of fruit and vice versa. Instead, it may be safer to target introduction of fruit and vegetables at periods of already low consumption like breakfast or after school and increase the number of serves at known times of existing consumption. Increasing fruit and vegetable consumption at breakfast or afterschool may also have a flow on effect to reducing the intake of other junk at these times, possibly replacing high fat/sugar spreads or snack foods.

For fruit intake, clear trends for peak consumption at school and low consumption at other times existed on weekdays and were similar for boys and girls. This indicates that nutrition messages for increased fruit consumption may be relevant for both sexes. Low levels of fruit consumption before school highlights a potential time period to increase fruit intake by adding it to breakfast. Given that breakfast contributes important nutrients that are not compensated for at other mealtimes (Deshmukh-Taskar et al., 2010), the addition of fruit would improve the dietary quality of breakfast and the overall day (Rampersaud et al., 2005). The low intake of fruit in the evening or after dinner indicates another potential gap to promote fruit consumption. A targeted dietary message might be, “Not many adolescents think about fruit as an after dinner food. Would you like to set a goal to add in an extra piece of fruit at this time?” On weekends fruit consumption was less than on weekdays. Two predictors of fruit consumption are parental facilitation and fruit availability (Sandvik et al., 2010, Pearson et al., 2009c), whilst availability of less
healthy foods is inversely related to fruit intake (Larson et al., 2008), hence fruit packed to take to school may be more likely to be eaten than if the adolescent is at home on a weekend with more independent food choices. Given such low overall consumption of fruit, weekend days offer large time periods for increasing fruit intake. Facilitators might encourage goal setting as follows, “Teenagers often forget about eating fruit on the weekend. Would you like to set a goal around eating fruit on Saturdays and Sundays?”

Vegetable intake on weekdays occurred mainly at dinner and may reflect the structure of the family evening meal. Eating dinner with the family has been associated with greater consumption of vegetables for both boys and girls, with higher intakes of several nutrients associated with vegetables including fibre, folate and B vitamins (Gillman et al., 2000). This presents an opportunity to improve on an existing healthy behaviour by increasing the number of serves at dinner. Vegetable consumption at other times of the day was negligible, indicating possible opportunities for promoting consumption. The way that vegetables are presented may influence the amount consumed, with lunch vegetables being restricted to fitting into a sandwich (mostly lettuce or tomato), as opposed to greater amounts of cooked vegetables at dinner. Identifying novel times and ways to add vegetables to the diet might be useful to increase overall vegetable food consumption. On the weekend vegetable consumption was less than on weekdays, similar to patterns in fruit consumption, perhaps relating again to less structured routines on weekends like watching TV at meals (Feldman et al., 2007) or higher incidences of eating out (Taveras et al., 2005a), both of which have been associated with lower intake of vegetables. A targeted dietary message might be “A late breakfast following a weekend sleep-in is a good time to squeeze in some vegies like baked beans. You could choose to set a goal around having vegies in your brunch.”

4.4.2 Junk food

Fast food trends on weekdays were similar for both boys and girls with weekday evening meals including the highest amounts of fast food. This is a concern given that whilst this time period is also the time for greatest vegetable consumption,
greater fast food intake is associated with lower intakes of vegetables (Taveras et al., 2005a, Larson et al., 2008). Although intake of fast food for girls did not differ between weekday and weekend days, boys significantly increased their intake of fast food on the weekend. Eating out of home, including fast food restaurants, has been identified as a significant risk factor for greater consumption of energy and fat (Lachat et al., 2012) and may explain some of the differences in energy intake between boys and girls in this study. This difference in consumption habits may indicate the need to develop gender specific strategies to address the barriers and motivators to reducing fast food intake, particularly on weekends when adolescents may have more independence regarding food selection. The lack of a time of day pattern for fast food consumption on weekends makes it difficult to develop time specific targets, other than overall reduction on weekend days. For example, “Adolescents eat the most fast food on the weekends. When are you more likely to eat fast food on the weekends? You might like to plan ahead to avoid the fast food trap?”

Trends in SSB consumption reflect that of fast food consumption, possibly as a result of fast food meal deals that include a burger, fries and soft drink. The role of sugar-sweetened beverages in the development of obesity remains unclear, but associations with increased risk of chronic disease make it an important strategy to reduce obesity-related health risk (Collins et al., 2013). In boys, weekends were the periods of greatest probability and highest consumption of sugar-sweetened beverages, again suggesting the need for gender specific strategies. It has been postulated that sugar-sweetened beverages have the potential to displace calcium-rich beverages like milk in adolescents (Harnack et al., 1999), which appears to reflect the low reported calcium intakes in the food records. It may be beneficial to encourage the replacement of sugar-sweetened beverages with milk-based beverages, particularly at main meals for both boys and girls, given the low calcium intake of adolescents. For example, “Teenage boys often drink sugary drinks with their main meals. What do you have to drink with your meals? You could choose to set a goal around swapping drinks to meet your healthy eating goals.”
Girls’ consumption of other junk, which was from crisps, packaged lunchbox snacks and high fat spreads, was significantly higher during the day at school, as well as higher in the same period across the weekend, whilst intake for boys did not differ with time of day. This might indicate a specific time point for the most effective reduction of other junk for girls, whilst reductions by boys across the whole day are likely required. A targeted dietary message might be, “Teenagers often take junk food with them to school. What sorts of foods could you take out of your lunchbox to stick with your healthy eating goals? What could you replace these foods with?”

4.4.3 Limitations

Potential limitations to this study include that self-reported dietary intake is subject to potential underreporting, particularly in adolescence and with increasing BMI status (Bandini et al., 2003, Singh et al., 2009). Overweight adolescents who underreport with one dietary data collection tool are likely to underreport with all tools, and this limitation is very difficult to overcome in any study. Regardless, the food records in this study were of high quality, likely reflective of the education provided on recording and estimating foods, as well as the monetary incentive. No records had to be excluded for extremely low intakes and results are in-line with the current national data that includes healthy weight and overweight adolescents, particularly relating to percent energy contribution by macronutrients (including fat) (Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008) and junk food consumption (Rangan et al., 2008). Low reported intakes of fruits and vegetables also suggest no evidence of selective over-reporting.

The small sample size and proportionately low numbers of boys in this study reduces the power and generalizability of these findings. Further research comparing data separately from Saturday and Sunday would strengthen the evidence regarding trends of food group intake. However, adolescents may be reluctant to record for longer periods of time.

This study described the eating habits of adolescents who had enrolled in a healthy lifestyle program and are potentially amenable to health advice and support; hence this may not reflect eating habits of all overweight adolescents. This is also a likely
strength, given the applicability for informing intervention design for such a target group.

The majority of participants in this study were white and from low-middle socio-economic backgrounds, which may limit generalizability of findings. Future research into adolescents with more varied cultural and socio-economic backgrounds may identify different patterns of consumption.

The suggestions made in this paper have been developed based on the trends observed in a group of overweight adolescents and need to be tested as part of an intervention. There is the potential that targeting certain behaviours at certain times may just shift those behaviours into a different time (e.g., avoiding fast food on weekend days may mean adolescents increase their fast food consumption on weekdays.) Research into the promotion of these messages as part of a family-centred, multi-disciplinary intervention is necessary to discover how best to encourage appropriate changes.

4.5 Conclusions

Results from this novel study represent the next step in developing targeted, evidence-based dietary interventions for overweight adolescents. The study provides an insight into the timing and food group consumption patterns of a group of overweight adolescents entering a healthy lifestyle program, allowing health professionals to choose the most effective dietary messages to include in their intervention. These may also be novel specific messages for adolescents and families, making them potentially more appealing to those for whom the general healthy eating message is too vague. Future research should investigate the temporal consumption patterns of other groups of adolescents, and test the implementation of targeted key messages with overweight adolescents seeking treatment.
Chapter 5.0  Study C: CAFAP primary outcomes study

The information in this chapter is an abridged version of the full paper published in PLOS ONE as:


The full paper has been amended to present only the nutrition primary outcomes data, which is directly relevant to this thesis, and for which the PhD student had primary responsibility. The aim of this study was to determine the effects of participation in Curtin University's Activity, Food and Attitudes Program (CAFAP) on the healthy eating behaviours of overweight and obese adolescents.

In this waitlist controlled clinical trial in Western Australia, adolescents (n = 69, 71% female, mean age 14.1 (SD 1.6) years) and parents completed an eight-week intervention followed by 12 months of telephone and text message support. Assessments were completed at baseline, before beginning the intervention, immediately following the intervention, and at three-, six-, and 12- months follow-up. The primary outcomes were servings of fruit, vegetables and junk food assessed by three-day food records.

During the intensive 8-week intervention fruit consumption increased (monthly incidence rate ratio (IRR) 1.3, 95% CI: 1.10, 1.56) and junk food consumption decreased (monthly IRR 0.8, 95% CI: 0.74, 0.94) and these changes were different to those seen during the waitlist period (p = .004 and p = .020 respectively).

Participating in CAFAP appeared to have a positive influence on the healthy eating behaviours of overweight and obese adolescents and
most of these changes were maintained for one year following the intensive intervention

5.1 Background

Adolescents who are overweight or obese are at greater risk of physical and mental health problems both during adolescence and subsequent adulthood (Herman et al., 2009, Soric et al., 2013). Physical activity, sedentary behaviour and healthy eating behaviours not only contribute to obesity but also have important independent health implications (Iannotti and Wang, 2013). The primary outcome focus of most interventions for overweight and obese adolescents has been adiposity rather than activity and healthy eating behaviours (Oude Luttikhuis et al., 2009). Aside from the importance of these behaviours to multiple health issues, including adiposity (Iannotti and Wang, 2013), a focus on weight-related outcomes may have unintended negative psychological consequences (Bacon and Aphramor, 2011). Evidence also suggests that interventions targeting both activity and healthy eating behaviours should be multi-disciplinary and involve families in community settings for sustained change (Oude Luttikhuis et al., 2009, Hoelscher et al., 2013, Zook et al., 2014). Whilst the few studies focussed on behavioural outcomes for overweight and obese adolescents have reported some encouraging findings (Nguyen et al., 2013, Davis et al., 2012, Bean et al., 2011), they have either lacked assessments of sustained change beyond immediately post-intervention (Davis et al., 2009b, Wengle et al., 2011, Evans et al., 2009, Kong et al., 2013) or lacked objective measures of activity (Nguyen et al., 2013, Davis et al., 2012, Evans et al., 2012). Additionally, few studies have used detailed dietary assessment methods, such as food records, to describe changes in healthy eating outcomes for adolescents (Collins et al., 2006).

Curtin University’s Activity, Food and Attitudes Program (CAFAP) was a community-based, family-centred behavioural intervention implemented by a multi-disciplinary team of health practitioners. The current study determined the effects of participation in CAFAP on activity and healthy eating behaviours of overweight and
obese adolescents and how behaviours were maintained for one year following the intervention. Specific dietary hypotheses tested were:

- Intake of fruit, vegetables and ‘junk food’ would change following participation in the CAFAP program and changes would be maintained for up to 12 months

- The rate of change of intake of fruit, vegetables and ‘junk food’ over the wait-list control period would differ from the rate of change over the intervention and maintenance periods.

5.2 Methods

5.2.1 Study design

This study was a staggered entry, within-subject, waitlist controlled clinical trial conducted in Western Australia. This design was selected to minimise ethical concerns with withholding treatment in a no treatment control for 18 months (Warren et al., 2007) and the likely unacceptably high drop-out over multiple assessments over an extended study duration for a no-treatment or minimal standard care control group. Additionally, the within-subject design reduces error variance from individual differences, thus increasing the power with the expected high dropout rates and reduced sample sizes found in previous studies (Oude Luttikhuis et al., 2009, Bean et al., 2011, Evans et al., 2009, Robbins et al., 2012). The trial was registered (Australia and New Zealand Clinical Trials Registry # ACTRN12611001187932, see Appendix G) and the protocol published (Straker et al., 2012). The study design complies with the TREND guidelines for transparent reporting of nonrandomized evaluations of behavioural and public health interventions (see Appendix H). Participants were assessed at six time-points including baseline, 3-months after baseline prior to beginning the intervention (end of waitlist period), immediately following the 8-week intervention (end of intervention period), and at 3-, 6-, and 12-months following the intervention (maintenance periods). Entry into the program was staggered into three waves, beginning in February, May and August 2012 to control for bias from external
events and seasonal changes. Follow-up assessments were completed by December 2013. The program was conducted at three sites (two urban and one rural) with a high proportion of low socio-economic status residents. Curtin University Human Research Ethics Committee approved all procedures (HR105/2011) (see Appendix A). Written informed assent was obtained from adolescents and consent was obtained from parents prior to commencing the study (see Appendix I).

5.2.2 Recruitment and participants

One hundred and twenty three participants enquired about the program from the community following information provided by health professionals, community newspapers and radio media, and distribution of flyers, of which 69 entered the study. Recruitment began in late November 2011 and continued through to August 2012. To be included in the study, participants had BMI-for-age and sex greater than the 85th percentile on the Centers for Disease Control BMI-for-age growth charts (Kuczmarski et al., 2000) and passed a medical screening prior to participation (see Appendix J). Participants were excluded if their obesity was related to a diagnosed metabolic, genetic, or endocrine disease, were receiving current treatment for a psychological disorder, or were unable to attend sessions twice weekly at the community locations. Sample size estimates were reported in the protocol paper (Straker et al., 2010). Seven cohorts ranging in size from 6 to 13 adolescents and the same number of parents were conducted in three waves. Recruitment ceased after the planned three waves despite smaller than anticipated numbers due to grant funding constraints. Figure 5.1 shows the flow of participants through the study.
Figure 5.1. Participant flow diagram for the waitlist controlled trial of Curtin University’s Activity, Food, and Attitudes Program

- Entered Study n=69
- Baseline Assessment (n =68)
  - Food record n =59
  - Valid accelerometry n=56
    - Did not start intervention n=11
      - Lacked teen commitment n=8
      - Lacked parent commitment n=1
      - Relocation n=1
      - Unknown n=1
    - Did not complete intervention n=14
      - Lacked teen commitment n=7
      - Lacked parent commitment n=2
      - Scheduling/Transportation n n=4
      - Unknown n=1
- Pre-Program Assessment (n=58*)
  - Food record n =53
  - Valid accelerometry n=49
- Completed Intervention n=44
- Post-Intervention Assessment (n=44)
  - Food record n =36
  - Valid accelerometry n=30
    - Lost to follow-up at 3-months n=4
      - Lacked teen commitment n=2
      - Lacked parent commitment n=2
    - Lost to follow-up at 6-months n=3
      - Scheduling/Transportation n=1
      - Unknown n=1
- 3-Month Follow-up (n=40)
  - Food record n =35
  - Valid accelerometry n=27
- 6-Month Follow-up (n=37)
  - Food record n =33
  - Valid accelerometry n=19
- 12-Month Follow-up (n=34)
  - Food record n =30
  - Valid accelerometry n=17
- Lost to follow-up at 12-months n=3
- Total Drop-Outs n=35

* Includes one participant who entered at pre and did not complete baseline assessment
5.2.3 Overview of intervention

This intervention was adapted to be conducted in the community from a previous program conducted in healthcare and university settings. Additional detailed formative work with adolescents, researchers and practitioners guided the development and refinement of the curriculum (Smith et al., 2014a). In summary, a team of 13 multidisciplinary community practitioners (psychologist, physiotherapist/exercise physiologist, dietitian) were trained to implement the program across the seven cohorts, with one facilitator from each domain working with each cohort typically. The theoretical framework for the intervention was self-determination theory (Deci and Ryan, 2000) and goal setting theory (Locke and Latham, 1990) and is described in detail elsewhere (Fenner et al., 2013). Both instructors and parents were encouraged to provide a need-supportive environment to increase adolescents’ autonomous motivation for physical activity and healthy eating behaviours.

The initial 8-week intervention included 2-hour group sessions twice per week in community locations. Both adolescents and parents participated in all sessions, with each session having separate and joint activities. An outline of the sessions and facilitators involved in each session is provided in Appendix K. Phone contact was made with participants who missed a session to increase attendance adherence. At every session, adolescents participated in 45-minutes of enjoyable physical activity and a behavioural component on healthy eating, activity and overcoming barriers. During the CAFAP activity sessions, participants were taught to self-monitor their heart rate and self-perceived level of exertion. The sessions began with a warm up, usually 1-2 group games, to increase the heart rate and body temperature in preparation for the circuit exercises. During the circuit training, participants moved through alternate ‘huff and puff’ and ‘strength’ stations. ‘Huff and puff’ stations, like boxing, were designed to increase the participants’ heart rate and increase their level of cardiovascular exertion. ‘Strength’ stations included a focus on different parts of the body, specifically trunk (e.g., oblique crunches), upper limb (e.g., bicep curls) and lower limb (e.g., squats). Sessions usually ended with another group game and cool-down stretches. Adolescents were encouraged to bring their own
music to play for the group during the activity sessions. Adolescents set weekly, manageable goals and parents were guided to set their own goals to support these adolescent goals.

During the 12-month follow-up, participants received structured telephone and text message contact at a decreasing frequency based on the same theoretical principles and key messages as during the intensive face-to-face contact period. Contact was based on self-determination theory and goal setting theory and focused on eating more fruits and vegetables, eating less junk food, being less sedentary and being more active. The structuring of text messages is described in detail elsewhere (Smith et al., 2014b). The phone coaching was completed by members of the facilitation/assessment team who were well known to participants and aimed to provide structure, support attempts at change, and promote adolescents’ sense of autonomy. A protocol for adverse events was in place, but no adverse events were reported. Program fidelity was assessed on several occasions for each site by independent observation.

Further details about the intervention, including resources for health professionals wishing to conduct similar programs, are provided at the study website: [http://cafap.curtin.edu.au/](http://cafap.curtin.edu.au/).

### 5.2.4 Detailed description of dietary component

#### 5.2.4.1 Theoretical basis

As with the overall intervention, the CAFAP dietary intervention was based on self-determination theory and goal setting theory (Deci and Ryan, 2000, Locke and Latham, 1990). Facilitators were dietitians who were trained in the application of these two theories. The key components of self-determination theory were rephrased to teach parents about what adolescents need to change their behaviours, and how parents could support this (Fenner et al., 2013). In summary, adolescents needed to feel competent in their abilities, to feel they could choose for themselves and to feel they had a sense of belonging. To support this, parents were encouraged to demonstrate three main behaviours. Firstly they were encouraged to ‘provid
structure’ through setting consistent guidelines for behaviours, offering assistance to set realistic goals and offering positive feedback for progress. Secondly they were encouraged to ‘support adolescent choices’ by using neutral language like ‘could’ instead of ‘should’, offering praise for attempts at behaviour change and providing meaningful reasons when asking the adolescent to do something. Thirdly, parents were encouraged to ‘be involved’ by talking with their adolescents and showing interest and affection towards them. Based on the goal setting theory, both parents and adolescents were taught the process for setting goals. Adolescents were encouraged to set goals based on their intrinsic motivations and parents were taught to set goals to support their adolescents, thus creating a sense of autonomy and involvement as per the needs identified in self-determination theory. Adolescents were provided with a list of optional goal ideas that had been useful for other adolescents, to assist them with setting their own goals. Additional skills were taught to parents, such as food shopping, budgeting and meal planning, to assist them to provide structure for their adolescents. Adolescents were also taught a number of healthy eating skills such as food label reading and food preparation, to help them feel competent in their abilities.

5.2.4.2 Development and pre-testing

The development of the food sessions was based on a healthy eating approach used in the CAFAP pilot study, that was further refined following qualitative evaluation (McManus et al., 2012). Two key messages were used throughout the intervention to tie the food sessions together. These were ‘Eat more fruit and vegetables’ and ‘Eat less junk food’. All of the sessions were grounded in self-determination theory and goal setting theory and related to the key food messages (eat more fruit and vegetables, eat less junk food).

5.2.4.3 Session content

The topics for the food sessions are shown in Table 5.1 and the literature to support the selection of each of these topics has been included as Appendix L. Further, the majority of the ‘attitudes’ sessions focussed on the development of skills to support dietary behaviour change. This included sessions on goal setting, overcoming
barriers and problem solving. Parents were also provided with additional sessions about parenting adolescents, developing parent-teen relationships and identifying existing local services in the community.

Table 5.1 Session content of the dietary component of CAFAP

<table>
<thead>
<tr>
<th>Topic</th>
<th>Who attended</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Healthy eating</strong>: energy balance, basic nutrition principles, variety and nutrients</td>
<td>Adolescents and parents</td>
</tr>
<tr>
<td><strong>Portion size</strong>: portion size guidelines using household items to equate to food serves, food group intake</td>
<td>Adolescents and parents</td>
</tr>
<tr>
<td><strong>Fast food and dinner</strong>: Fast food nutrition content and parent planning for ‘fast’ dinners</td>
<td>Parents</td>
</tr>
<tr>
<td><strong>Family food</strong>: review of key food messages, identification of positive and less positive food habits of family members, encourage positive eating behaviours to use in goal setting</td>
<td>Adolescents and parents</td>
</tr>
<tr>
<td><strong>Snacks</strong>: problem solving, snacks that help you eat more fruit and vegetables and eat less junk food</td>
<td>Adolescents and parents</td>
</tr>
<tr>
<td><strong>Food budgeting</strong>: money spent on food groups, planning to get more good food for your money</td>
<td>Parents</td>
</tr>
<tr>
<td><strong>Food labelling</strong>: understanding labels to choose healthier options and identify junk foods, sugar in drinks</td>
<td>Adolescents and parents</td>
</tr>
<tr>
<td><strong>Supermarket visit</strong>: nutrition and cost of foods, reviewing food labelling skills and budgeting skills</td>
<td>Parents</td>
</tr>
<tr>
<td><strong>Cooking healthy snacks</strong>: cooking healthy snacks with fruits and vegetables</td>
<td>Adolescents</td>
</tr>
<tr>
<td><strong>Cooking healthy snacks</strong>: cooking healthy snacks with fruits and vegetables</td>
<td>Parents</td>
</tr>
<tr>
<td><strong>Recipe ideas</strong>: modifying recipes to be tasty and healthy</td>
<td>Parents</td>
</tr>
<tr>
<td><strong>Cooking celebration</strong>: cooking healthy party foods</td>
<td>Adolescents and parents</td>
</tr>
</tbody>
</table>
5.2.4.4 Goal setting

To assist with goal setting, adolescents were provided with an estimate of their current activity and food behaviours, as taken from the three day food records and physical activity measures completed at baseline. These intakes were compared to estimates of intakes of the general adolescent population (Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008) to highlight that CAFAP participants often weren’t different to the rest of the population. The long-term goal setting component of CAFAP included a section on healthy eating, where adolescents were encouraged to choose the number of servings of fruit, vegetables and junk foods that they were aiming for by the end of the intervention. They were taught how to set achievable goals based on the feedback regarding their previous intakes. The weekly goal setting component of CAFAP was based on a similar concept, but adolescents were encouraged to break down their long-term goals into smaller goals to achieve each week. Adolescents were also encouraged to identify their motivations for behaviour change (for example, to feel better on the inside). Facilitators helped adolescents to identify intrinsic motivators for change where possible. Adolescents then discussed their goals with their parent, who set subsequent goals based on supporting their adolescents’ goals. Each week participants had the opportunity to reflect on the goals they had previously set, and rate the extent that the goal had been achieved. Facilitators used this opportunity to encourage adolescents to identify barriers to achieving their goals, and ways to overcome these in the following week. At the end of the eight week intervention, adolescents and parents were asked to rate the extent to which they achieved their long-term goals, and then set new goals for the maintenance period.

5.2.5 Measures

The dietary primary outcomes were serves of fruit, vegetables and ‘junk food’ (Straker et al., 2012). The other study primary outcomes were time in sedentary, light, moderate and vigorous activity as measured by accelerometry and described elsewhere (Straker et al., 2012)
5.2.5.1 Food intake

Dietary intake was assessed using a 3-day food record including one weekend day (see Appendix M). Adolescents were trained in completing the record and estimating portion size using household measures. The completed food record was reviewed by the research dietitian and details were clarified with the adolescent. The records were analysed for the number of serves of fruits and vegetables, determined according to the Australian Guide to Healthy Eating serve sizes (National Health and Medical Research Council, 2013c), and junk food according to published criteria (Rangan et al., 2008, National Health and Medical Research Council, 2013c). Serves of fruit (150 g fresh fruit and 30 g dried fruit) were calculated excluding fruit juice, given the difficulty in identifying juice that had been sweetened and the propensity to consume excessive amounts of juice. Vegetables (75 g) included all vegetables other than fried potato, which were included in the junk food serves. The term ‘junk food’ was used to describe foods that are considered energy-dense, nutrient-poor foods (Rangan et al., 2008, National Health and Medical Research Council, 2013c) and do not belong to the core food groups. To account for the typically high prevalence of underreporting in self-reported food intake (Singh et al., 2009), underreporting ratios were calculated. Total energy expenditure was estimated from resting energy expenditure calculations (Henes et al., 2013), and activity energy expenditure from individual participant accelerometer data (Puyau et al., 2004). When accelerometer data was missing, energy activity energy expenditure was calculated for a sedentary individual (Puyau et al., 2004). A ratio of reported energy intake from diaries and total energy expenditure (rEI:TEE) was calculated and included as a continuous variable in the analyses (Jennings et al., 2012, Rennie et al., 2007).

5.2.5.2 Other measures

Participants completed surveys of basic demographic information and anthropometric measurements were taken at each assessment at the community facility where the program was delivered. See Appendix N for the assessment protocol. Weight and height were measured and used to calculate age and sex
adjusted BMI z-scores (Children's Nutrition Research Center, 2003). Staff assessing outcomes were not blind to the participant’s intervention stage, but did not have access to participant prior scores. Participants were not able to be blinded to the intervention. Data on adolescent fitness, food behaviours, perceived parent need-supportive behaviours, autonomous motivation, mental health and quality of life; parent mental health, autonomous motivation to support adolescents, demonstration of need-supportive behaviours, and family functioning; adolescent and parent perceptions of facilitator support; program fidelity; and adolescent, parent and facilitator perceptions of the program were collected and are being reported in detail elsewhere.

5.2.6 Statistical analyses

Data were visually inspected for potential outliers. Outliers were checked for data entry errors and corrected where applicable, and biologically implausible values were removed. Data were screened for normality using histograms and multiple measures of location.

Descriptive statistics were calculated (means and standard deviations) at each time point. A comparison of baseline values between those participants completing both the intervention and maintenance periods were compared with those not completing either the intervention or maintenance periods using ANOVA and $\chi^2$.

Participants who participated in at least 2 assessments were included in statistical models (total used in analysis, n=56). Missing values were accounted for in the mixed models, which uses a likelihood-based estimation procedure resulting in non-biased estimates by imputation of missing responses based upon the surrounding responses and modelled covariance structure. Count data of servings of fruit, vegetables, and junk food were analysed using negative binomial regression utilising generalized estimating equations, with an exchangeable correlation structure and robust estimates of standard errors. Due to the bias that is likely to result from excluding underreporters (Rennie et al., 2007), the ratio of estimated energy expenditure and reported energy intake was included in the models for food servings as a time-varying covariate (Jennings et al., 2012). Linear contrasts are
presented as incidence rate ratios (IRR). Model fits were assessed through residual plots and diagnostics.

In all models, a priori linear contrasts compared the mean point estimate at each time point to pre-intervention point estimates. Further, the monthly rates of change over the following periods were estimated: the waitlist period between baseline and pre-intervention, the intervention period between pre-intervention and post-intervention, and the maintenance period between post-intervention and 12-months. Due to the waitlist control design, changes over the intervention and maintenance periods were compared to changes during the waitlist period. The change between periods was adjusted for varying length of time between assessments by expressing changes as rate of change per month rather than absolute change across the period. No explicit control for multiple comparisons was performed, rather 95% confidence intervals for all parameter estimates are presented together with actual p-values where appropriate. All analyses were conducted using Stata/IC 13.0 for Windows (StataCorp LP, College Station TX, USA).

5.3 Results

5.3.1 Baseline characteristics

Adolescents who completed the study were comparable to those who dropped out before completing the intensive intervention or during the maintenance phase (Table 5.2).
Table 5.2 Baseline characteristics of adolescents in Curtin University’s Activity, Food, and Attitudes Program in total sample and those who did and did not complete the program (n, % or Mean (SD))

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Did not complete intervention</th>
<th>Did not complete maintenance</th>
<th>Completed</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>68*</td>
<td>25</td>
<td>10</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Gender (% female)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.31</td>
</tr>
<tr>
<td>Age (years)</td>
<td>14.1</td>
<td>14.6 (1.7)</td>
<td>13.4 (1.4)</td>
<td>13.9 (1.5)</td>
<td>0.10</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>162.9</td>
<td>164.4 (9.4)</td>
<td>161.4 (7.4)</td>
<td>162.2 (8.5)</td>
<td>0.54</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>87.8</td>
<td>89.0 (22.5)</td>
<td>81.5 (14.5)</td>
<td>88.7 (20.5)</td>
<td>0.59</td>
</tr>
<tr>
<td>BMI (kg/m2)</td>
<td>32.8</td>
<td>32.6 (6.5)</td>
<td>31.2 (4.7)</td>
<td>33.5 (6.6)</td>
<td>0.59</td>
</tr>
<tr>
<td>BMI z-score</td>
<td>2.1</td>
<td>2.0 (0.5)</td>
<td>2.1 (0.3)</td>
<td>2.2 (0.4)</td>
<td>0.60</td>
</tr>
<tr>
<td>N (valid food record)</td>
<td>58</td>
<td>16</td>
<td>10</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Fruit (servings/day)</td>
<td>0.8</td>
<td>0.8 (1.0)</td>
<td>0.4 (0.3)</td>
<td>0.8 (0.8)</td>
<td>0.29</td>
</tr>
<tr>
<td>Vegetables (servings/day)</td>
<td>1.2</td>
<td>1.3 (1.1)</td>
<td>1.2 (1.2)</td>
<td>1.2 (1.0)</td>
<td>0.96</td>
</tr>
<tr>
<td>Junk food (servings/day)</td>
<td>5.8</td>
<td>6.4 (4.6)</td>
<td>5.0 (1.8)</td>
<td>5.7 (3.4)</td>
<td>0.60</td>
</tr>
<tr>
<td>Energy (kJ/day)</td>
<td>8101.1</td>
<td>8405.8 (2807.0)</td>
<td>7236.8 (1854.6)</td>
<td>8215.3 (2530.1)</td>
<td>0.48</td>
</tr>
</tbody>
</table>

*One participant did not complete baseline testing but entered the study during the waitlist period.

P-values for ANOVA comparison between three groups: Did not complete intervention, Did not complete maintenance, Completed

5.3.1.1 Changes in servings of fruit, vegetables, and junk food

Servings of fruits, vegetables and junk food did not change significantly from baseline to pre-intervention as seen in Table 5.3.
Table 5.3 Mean healthy eating point estimates and rates of change across the study

<table>
<thead>
<tr>
<th>Point Estimates</th>
<th>Servings per day (SE)</th>
<th>Baseline</th>
<th>Pre</th>
<th>Post 3-months</th>
<th>6-months</th>
<th>12-Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruitb</td>
<td></td>
<td>0.8 (0.1)</td>
<td>0.6 (0.1)</td>
<td><strong>1.1 (0.2)</strong>*</td>
<td>1.1 (0.1)*</td>
<td>0.9 (0.1)*</td>
</tr>
<tr>
<td>Vegetables</td>
<td></td>
<td>1.3 (0.2)</td>
<td>1.3 (0.1)</td>
<td>1.3 (0.2)</td>
<td>1.4 (0.2)</td>
<td><strong>1.7 (0.2)</strong>*</td>
</tr>
<tr>
<td>Junk Food</td>
<td></td>
<td>4.6 (0.3)</td>
<td>4.6 (0.4)</td>
<td><strong>3.2 (0.3)</strong>*</td>
<td>3.4 (0.3)*</td>
<td><strong>3.3 (0.4)</strong>*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rate of Change</th>
<th>Monthly incidence rate ratio (95% CI)</th>
<th>Waitlist Period (Baseline to Pre)</th>
<th>Intervention Period (Pre to Post)</th>
<th>Maintenance Period (Post to 12-months)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.94 (0.86, 1.03)</td>
<td><strong>1.33 (1.11, 1.60)</strong> †</td>
<td>0.99 (0.97, 1.02)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.00 (0.91, 1.10)</td>
<td>1.00 (0.85, 1.18)</td>
<td>1.01 (0.98, 1.03)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.00 (0.95, 1.06)</td>
<td><strong>0.83 (0.74, 0.94)</strong> †</td>
<td>1.02 (1.00, 1.05)</td>
</tr>
</tbody>
</table>

Healthy eating variables estimated from negative binomial regression using general estimating equations with random intercepts adjusted for underreporting ratio
*significant difference from Pre point estimate (p<.05)
†significant difference in the rate of change compared to Waitlist Period (p<.05)

Following the intensive intervention, there was a significant increase in the point estimate of servings of fruit and the rate of change in fruit consumption during the intervention period was significantly different to the rate of change over the waitlist period, indicating an increase in fruit consumption (see Figure 5.2). There was no significant change in vegetable consumption during the intensive intervention period. Following the intervention, the point estimate of servings of junk food decreased and the rate of change during the intervention period was significantly different to the rate of change over the waitlist period.
During the entire 12-month maintenance period, there were minimal changes in servings of fruit, vegetables and junk food, except the point estimate of vegetable consumption was higher at 6-months compared to pre-intervention.

**Figure 5.2 Mean (+ standard error) changes in servings of fruit, vegetables and junk food (results from negative binomial regression)**

*significant difference from pre (p<.05)
†significant difference between slopes (p<.05)

### 5.3.1.2 Secondary outcome: BMI z-scores

BMI z-scores did not change significantly during the waitlist or intervention periods but the point estimates at 3-months (2.05, SE 0.02), 6-months (2.03, SE 0.02), and 12-months (2.03, SE .04) were lower (p=.035, p=.042, p=.060 respectively) than at pre-intervention (2.11, SE 0.02). The rates of change in BMI z-scores were not different between the waitlist period (-0.004 per month, 95% CI: -0.02, .01), intervention period (-0.01 per month, 95% CI: -0.04, 0.01) and maintenance period (-0.005 per month, 95% CI: -0.01, 0.002).
5.4 Discussion

Overweight and obese adolescents participating in CAFAP were able to make small, statistically significant and potentially clinically useful improvements in physical activity, sedentary time and healthy eating behaviour trajectories and maintained many of these changes for one year following the intensive intervention. This was the first objective assessment of a community-based family-centered intervention for overweight and obese adolescents focussed on behaviours as the primary outcomes.

5.4.1 Healthy eating

Compared to research on physical activity levels during adolescence, even less is known on how food behaviours typically change during this life stage (Smith et al., 2014c), partially due to the difficulty in obtaining high quality food record data from adolescents.

During the intervention, servings of junk food decreased and servings of fruit increased. There were no changes in vegetable consumption. Evidence from studies in children suggests that fruit consumption may increase more in response to intervention than vegetable consumption (Evans et al., 2012). While other studies have reported increases in selected measures of diet or macronutrients (Nguyen et al., 2013, Shrewsbury et al., 2011a), only one previous study has used food recalls to measure changes in fruit, vegetable, or junk food intake in overweight and obese adolescents. One program (Bean et al., 2011) increased combined fruit and vegetable consumption by 0.6 servings per day after 6 months of intervention, similar to the 0.5 servings per day increase in fruit in CAFAP. Using a 15-item food frequency questionnaire, the Loozit study found an improved proportion of participants meeting fruit and vegetable guidelines after a two-month intervention (Shrewsbury et al., 2011a). While the consumption of fruits and vegetables following participation in CAFAP still fell short of Australian guidelines for 2 serves of fruit and 5 serves of vegetables each day,(National Health and Medical Research Council, 2013c) the increase of half a serve of fruit per day almost doubled the amount of fruit consumed by participants at baseline. The magnitude of change was
also much greater than the 10% modelled *a priori* (Straker et al., 2012) and the changes observed in activity. Evidence on the precise health impact of a change of this magnitude given baseline levels of fruit, vegetables and junk food is lacking and thus an important topic for future research.

In the CAFAP intervention, positive changes in fruit and junk food consumption were successfully maintained up to 12 months following the intervention, however, junk food had increased at 12 months. Additionally, vegetable consumption increased 6 months after the intervention. The Loozit study found no changes in fruit, vegetable, or junk food consumption after 12 or 24 months following the intervention (Nguyen et al., 2012b, Nguyen et al., 2013). CAFAP focused on behaviours instead of weight loss, which may have contributed to the maintained changes in healthy eating seen in the current study.

### 5.4.2 Limitations

The assessment utilised detailed 3-day food records. While underreporting is known to be a problem of food records, particularly in overweight and obese adolescents (Singh et al., 2009), they remain the best available method for detecting short-term changes in diet and intake patterns (Kirkpatrick et al., 2014). Additionally, the energy expenditure estimates from accelerometry were compared to reported energy intake, underreporting was consistent throughout the study and the underreporting ratio was included in the statistical models (Rennie et al., 2007, Jennings et al., 2012).

The study assessments were taken at multiple time-points during a year-long maintenance period, addressing a noted paucity of studies with follow-up of sustained behaviours beyond immediately post-intervention (Evans et al., 2012, Oude Luttikhuis et al., 2009). As is common with many adolescent interventions (Oude Luttikhuis et al., 2009, Bean et al., 2011, Evans et al., 2009, Robbins et al., 2012), there was high attrition through the study but analyses were performed on all participants with two time points of data, and sensitivity analyses confirmed findings in those who completed the study. A process evaluation of the intervention is currently underway to explore barriers to successful completion.
While this quasi-experimental study did not have a concurrent control group, the waitlist period provided a within-subject control period comparison for changes seen in the outcomes across the intervention and maintenance periods. This design was selected as providing the best evidence enabling high external validity (staggered entry) and high internal validity (within person control period) whilst providing best practice health behaviour interventions for high-risk adolescents with a 12 months follow-up. The lack of literature on dietary trends across adolescence does not provide a reference for changes in healthy eating outcomes. Whilst there may have been some reactivity during the waitlist period, changes during the intervention were greater than those seen during the waitlist period, suggesting positive effects of the intervention on servings of fruit and junk food.

While behaviours are critical outcomes, further research is needed to determine whether such changes in behaviours translate into changes in fitness, mental and physical health status and quality of life. Further research to understand the patterns for healthy eating behaviours (such as which meals or specific foods are best to target) could inform more effective interventions, as could a process evaluation of the current study. Research should also explore whether the effects observed were due to the theoretical mechanism proposed (Fenner et al., 2013), that is, whether training parents in need-supportive behaviours can enhance adolescent autonomous motivation and subsequent healthy eating behaviours.

The delivery of the program by community health professionals in community settings, whilst challenging, provided high external validity for the findings to be replicable. However, the small sample size and delivery of the intervention in just three sites of similar populations suggest caution in extrapolation to other samples with different social and other characteristics.

5.5 Conclusions

This study found that a community-based, family focussed multi-disciplinary physical activity and healthy eating intervention can have a positive influence on
behaviours in overweight and obese adolescents and many of these changes can be maintained for up to a year following the intervention. This is encouraging, especially when contrasted with the common pessimistic trajectories of healthy eating during adolescence. Improving healthy eating behaviours during adolescence is important for current and future physical and mental health and thus successful programs should be made widely available to benefit as many adolescents as possible.
Chapter 6.0 Study D: Changes in nutrition outcomes after participation in CAFAP

The information in this chapter is an extended version of the manuscript to be submitted to the Journal of the Academy of Nutrition and Dietetics.

This chapter includes analysis of overweight adolescent diet following participation in Curtin University’s Activity, Food and Attitudes Program (CAFAP). The aim of this study was to assess adolescent dietary change for food groups, energy intake, nutrients, eating behaviours and adherence from post-intervention to 12 months post-intervention.

The trial design was a staggered entry, within-subject, waitlist controlled clinical trial. Overweight adolescents (n = 69, 71% female, mean age 14.1 (SD 1.6) years) and their parents participated in an eight-week healthy lifestyle intervention (CAFAP) followed by a 12 month maintenance period involving text message and telephone contact. Adolescents completed assessments at baseline, immediately pre-intervention, immediately post-intervention, and at three-, six- and 12-months post-intervention. Diet was assessed using three day food records and a brief eating behaviour questionnaire.

Adherence to the dietary intervention was assessed post-intervention by calculating the number of participants who reported changes in their intake consistent with the key dietary intervention messages. Changes in dietary outcomes were assessed using linear mixed models including random intercepts, to account for the within-person repeated measures. The models were adjusted for underreporting. To account for differences in the time between assessments, the monthly rate of change during each period was compared.

The findings from this study showed that ‘Eat more vegetables’ was the intervention message least adhered to (49% post-intervention) and ‘Eat less junk food’ was the intervention message most adhered to (69% post-intervention). Adherence to all of the dietary intervention messages
reduced over time following the intervention. Eating behaviours did not change significantly during the intervention. There were some changes in self-reported eating behaviours during the maintenance period including increased consumption of breakfast ($p=.008$) and reduced consumption of fast food ($p=.017$) and sugar sweetened beverages ($p=.008$). During the intervention energy intake did not change but nutrient changes included reductions in fat ($p=.002$) and saturated fat ($p=.001$), along with an increase in fibre ($p=.016$). During the maintenance period, energy intake remained stable but fat and saturated fat intake gradually returned to baseline levels over the 12 months.

Adherence measures showed that a large proportion of participants adhered to the key dietary intervention messages, with modest dietary changes seen following intervention and lessening over time. Detailed dietary reporting in future studies, including measures of adherence, is critical to improve the understanding of how overweight adolescent diet changes following intervention; which can be used to inform future targeted intervention development.

6.1 Introduction

6.1.1 Treating adolescent obesity

Current rates of overweight and obesity in adolescence are concerning given the associated negative medical and psychosocial consequences (Maggio et al., 2014). Strategies for treating adolescent obesity include lifestyle interventions involving diet, physical activity and behaviour change components. Current evidence supports interventions with a comprehensive multi-disciplinary approach including a dietary component (Barlow, 2007), a minimum of twelve month follow-up (Glenny et al., 1997), contact of moderate to high intensity (Whitlock et al., 2010) and a family-based design with a focus on food and activity behaviours and attitudes (Oude Luttikhuis et al., 2009). However, few details about the implementation and evaluation of such interventions have been documented and a clear need for timely
and detailed evaluation of adolescent obesity programs has been identified (Ho et al., 2012, Oude Luttikhuis et al., 2009, Denney-Wilson and Baur, 2007).

6.1.2 Dietary treatment of adolescent obesity
Diet is a critical component of obesity interventions (Hoelscher et al., 2013) and dietary treatment can achieve relative weight loss in adolescents, yet little is known about the design of effective dietary interventions for adolescents (Collins et al., 2007). There is no standardised dietary treatment for obese adolescents and most evidence-based, multi-disciplinary interventions use differing approaches to encourage dietary change in this group. These can include a focus on specific eating behaviours such as regular consumption of breakfast (Shaibi et al., 2012), or specific intake such as a modified stoplight diet (Janicke et al., 2008a) or carbohydrate modified diet (Davis et al., 2009b). Additionally, interventions can be delivered by individual counselling sessions with a dietitian (Bean et al., 2011) or group based education and skill development around general healthy eating principles and behaviours (Shrewsbury et al., 2009, Steele et al., 2012, Savoye et al., 2011). There are surprisingly few trials in adolescents that have collected and reported detailed changes in participant dietary behaviours and intake data (Collins et al., 2006), limiting our ability to identify effective approaches for dietary behaviour change.

6.1.3 Dietary change following intervention
To date, changes in dietary behaviours following intervention have been modest and long-term follow-up has been lacking (Oude Luttikhuis et al., 2009). In multi-disciplinary interventions where dietary data was collected, there have been improvements reported in some self-reported eating behaviours (Nguyen et al., 2013), or dietary intakes including reduction in total energy intake (Janicke et al., 2008a, Bean et al., 2011), absolute fat intake (Shaibi et al., 2012, Bean et al., 2011) and sugar intake (Davis et al., 2009b). Of these family-based, multi-disciplinary interventions for adolescents, dietary findings have been limited by follow-up of less than twelve months (Shaibi et al., 2012, Bean et al., 2011, Davis et al., 2009b) or use of dietary intake measures that provide only limited information (Shrewsbury et al., 2009, Janicke et al., 2008a). Many interventions do not include outcome measures of dietary change (Savoye et al., 2011, Steele et al., 2012). This limits the
ability for future studies to replicate or compare dietary changes or measure adherence to the dietary interventions. This information is critical to the development of future dietary interventions for overweight adolescents (Collins et al., 2010).

6.1.4 Adherence to dietary interventions
Measures of adherence to the prescribed dietary intervention appear to be poorly described. In the adolescent studies reporting dietary outcomes, the proportion of participants adopting specific dietary targets of the intervention (i.e., adherence) were not reported (Nguyen et al., 2013, Janicke et al., 2008a, Bean et al., 2011, Shaibi et al., 2012, Davis et al., 2009a). This is of particular concern as low adherence to dietary recommendations is a primary reason for poor outcomes following intervention (Heymsfield et al., 2007). Without adherence measures, it remains unclear how the dietary interventions create change within multi-disciplinary interventions (Ho et al., 2013). However, quantification of adherence is impeded by a lack of guidelines for how to measure adherence and how to identify high or low levels of adherence (Vitolins et al., 2000). Adherence has been previously defined in adult studies as consuming a diet that meets ±20% of the nutrient recommendations associated with the dietary intervention (Foraker et al., 2014). However, measuring adherence to dietary behaviour change is more difficult as there may be many dietary behaviours targeted in an intervention. A previous pilot study in adolescents defined adherence to diet-related recommendations as performing the behaviours every day (Ratcliff et al., 2014). However, this study only included eight participants and employed an intensive method to assess adherence, using a self-administered electronic device to prompt adolescents to recall every activity of the previous day. The differences in study design and dietary interventions between trials highlight the importance of adopting adherence measures that suit the particular situation (Vitolins et al., 2000).

6.1.5 Aim
Against this background, the aim of this study was to assess dietary change from post-intervention to 12 months post-intervention for overweight and obese adolescents’ participating in a multi-component healthy lifestyle program (Curtin
University’s Activity, Food and Attitudes Program or CAFAP). The assessment included analyses of adolescent adherence to the dietary component of the intervention (including changes in the primary intervention behavioural targets), changes in selected eating behaviour strategies, and a detailed analysis of dietary nutrient intake as reported in three day food records.

6.2 Methods

6.2.1 Study design
This study was a multiple cohort, staggered-entry, waitlist controlled clinical trial conducted at three sites in Western Australia (two metropolitan areas and one regional area) (Straker et al., 2012). Briefly, overweight adolescents were recruited and assessed three months before the eight-week intensive phase of the intervention commenced, and assessed again immediately prior the intervention. This method was chosen because it was considered unfair to withhold services from obese adolescents in view of the lack of appropriate treatment service available (Warren et al., 2007), and the dual pre-participation assessments allowed for a within-subjects control period. The staggered start controlled for external seasonal and public event confounders to intervention effects. Further assessments were completed at the immediate conclusion of the eight-week program and again at three months, six months and 12 months post-program (Straker et al., 2012). This trial was registered on the Australian New Zealand Clinical Trials Registry (ACTRN12611001187932).

6.2.2 Participants
Between January 2012 and December 2013, 69 overweight or obese adolescents aged 11-16 participated in Curtin University’s Activity, Food and Attitudes Program (CAFAP). Participants were recruited via the health system, education system and from the general community and were screened by a medical practitioner for medical suitability prior to assessment. Further inclusion criteria was a BMI-for-age-and-sex above the 85th percentile on the standard Centers for Disease Control (CDC) BMI-for-age growth charts (Kuczmarski et al., 2000) (includes adolescents who are typically classified as overweight or obese). Height and weight were measured using
standardised protocols with BMI z-scores determined using the CDC online
calculator. Exclusion criteria included: obesity relating to an identified genetic,
endocrine or metabolic disease, current treatment for psychiatric disorders or
inability for parent and adolescent to attend twice weekly group sessions at a local
community site. This study was conducted according to the guidelines laid down in
the Declaration of Helsinki and all procedures involving human subjects/patients
were approved by the Curtin University Human Ethics Research Committee
(HR105/2011). Written informed assent/consent was obtained from all
adolescents/parents.

6.2.3 Intervention
CAFAP was a community-based, multi-disciplinary healthy lifestyle program directed
at overweight and obese adolescents and has been described in detail elsewhere
(Fenner et al., 2013, Straker et al., 2012) and in section 5.2.3. The focus of CAFAP
was increased physical activity, reduced sedentary behaviour, reduced junk food
intake and increased fruit and vegetable intake. The eight week intensive phase of
the intervention involved parents and adolescents and consisted of twice-weekly
group sessions run by a psychologist, physiotherapist/exercise physiologist or
dietitian. The intensive intervention period was followed by a tapered maintenance
phase over twelve months. The first three months of the maintenance phase were
considered to be ‘high intensity’ where adolescents received three theoretically
structured text messages per week and one phone coaching session per fortnight.
The next three month period included a tapering of contact to ‘medium intensity’,
where adolescents received a weekly text message and a monthly phone coaching
session. The ‘low intensity’ phase of the maintenance period occurred between six
and twelve months post intensive program and included monthly text messages
and quarterly phone coaching sessions.

6.2.4 Dietary intervention
The dietary component of the intervention was facilitated by Accredited Practising
Dietitians. Delivery style was guided by self-determination theory and goal setting
theory, in line with the theoretical underpinnings of the intervention (Fenner et al.,
2013). The dietary component focused on food groups rather than kilojoule intakes
or specific nutrients. Participants learnt skills to help them make healthy food choices and were not provided with structured meal plans as recent evidence suggests that these are not well-received by adolescents (Savoye et al., 2007). The three primary nutrition intervention messages were: eat more fruit; eat more vegetables; eat less junk food. The term ‘junk food’ is used to describe ‘discretionary’ foods that are considered energy-dense, nutrient-poor foods (Rangan et al., 2008, Dixon et al., 2007, National Health and Medical Research Council, 2013c). The delivery of the dietary component is described in detail in Chapter Five.

The dietary intervention consisted of 12 group education sessions with parents and adolescents regarding general nutrition, energy balance, food labelling, diet variety, fast food, lunch box food, portion size and recipe modification, with the key messages reinforced in each session. Parents were also given practical training in buying and preparing healthy food during a supermarket visit and both parents and adolescents were involved in cooking classes focusing on the preparation of healthy foods containing fruits and vegetables. Tailored feedback on the adolescent’s diet, taken from the initial three day food record, was provided to each participant to assist with adolescent goal setting. For example, the goal might be to build on their current fruit intake by having an extra serving on three days of the week. Participants were encouraged to identify their motivation for healthy eating, with an emphasis placed on intrinsic motivation. Self-monitoring strategies were used in combination with weekly goal setting sessions to support healthy eating changes. Parents also engaged in goal setting based on supporting the healthy eating goals set by their adolescent. For example, to support the adolescent healthy eating goal for fruit, the parent might set their own goal around ensuring the family had access to fresh fruit in the house.

6.2.5 Detailed dietary assessment

6.2.5.1 Nutrient intake

Three day food records were used in this study to provide comprehensive descriptive information about meal patterns and intake of foods and beverages without extensive reliance on participant memory (Thompson and Subar, 2013)
Appendix M). The food records were completed at all assessment points and used to assess changes in adolescent dietary intake. Three days was selected as it provides a reasonable compromise between understanding the variation in daily adolescent diets (Livingstone and Robson, 2000) and the risk of poor quality information due to excessive participant burden (Collins et al., 2010, Boushey et al., 2009). Prior to completing the food record, adolescents were given training and written instructions from the research dietitian regarding estimating portion size and household measures. The completed record was reviewed by the research dietitian for completeness and details of food and beverages consumed were clarified with the adolescent. Food records were analysed using the NUTTAB 2010 and AUSNUT 2007 databases (Foodworks 2009 version 6 software). Data was extracted for intakes of total energy, macronutrients and percentage contribution to energy intake, as well as micronutrients; zinc, iron, calcium, vitamin C and fibre. The results of food group analysis used in Study C are presented in this current study. The analysis methods are described in section 5.2.5.

6.2.5.2 Adherence to intervention messages
Key intervention messages for the nutrition component of CAFAP were to increase intakes of fruit and vegetables and reduce intakes of junk food. Adherence to the dietary intervention was measured by the percentage of participants who increased their intake of fruit and vegetables by at least 0.25 serves per day and reduced their intake of junk food by at least 0.5 serves per day. This was measured immediately and 12 months post-intervention using the data from three day food records (see ‘nutrient intake’ for details), with complete servings data reported in Chapter Five. There is no accepted definition of a clinically important change in servings of key food groups, so this magnitude of change was chosen to reflect at least a 10% change in servings. This reflects the expected changes in physical activity and dietary behaviours following intervention as described in the protocol paper (Straker et al., 2012).

6.2.5.3 Eating behaviours
A short food behaviour questionnaire based on validated questionnaires used in similar cohorts (Martin et al., 2008, Rutishauser et al., 2001) was used to assess
eating behaviours likely to be related to obesity (see Appendix O). Questions included frequency of breakfast consumption, frequency of fast food consumption (like McDonalds and KFC), frequency of eating meals as a family and sugar sweetened beverage consumption (like soft drink, soda, sports drinks, cordial). Participants responded to questions about eating behaviour frequency using a five point scale: Every day, 5-6 days per week, 3-4 days per week, 1-2 days per week, rarely or never. Further questions regarding perceived intake of fruit, vegetables and junk food asked for the usual number of serves consumed each day, based on standard Australian serving size descriptions (National Health and Medical Research Council, 2013c).

6.2.6 Statistical analysis

Data were visually inspected for potential outliers and checks completed for individual data entry errors or implausible values. Tests for normality were conducted using histograms. Descriptive statistics at each assessment point are presented as mean ± standard deviations (SD). T-tests were used to compare participants who completed to those who dropped out. All participants who participated in at least two occasions of data collection were included in the analysis. Adherence data is presented with additional separate results for those who completed all six occasions of data collection.

There is a high likelihood of underreporting by overweight and obese adolescents with food records (Singh et al., 2009). The use of a cut-off method of classification to identify under-reporters has the potential to exclude significant numbers of participants and introduce considerable bias (Rennie et al., 2007). In this study we chose to use the ratio of energy intake to total energy expenditure as a time-varying covariate (Jennings et al., 2012) in the mixed model described below. Total energy expenditure was estimated using resting energy expenditure estimation equations (Henes et al., 2013) and activity energy expenditure based on objectively measured accelerometry (Puyau et al., 2004). The use of individual activity data in the estimation of total energy expenditure is thought to be more sensitive than using generalized predictive equations (Rennie et al., 2007). Where accelerometer data was unavailable, total energy expenditure was estimated as 0.0149 kcal/kg/min,
based on the estimation equation validated by Puyau et al. (2004). The numbers of participants with accelerometer data differed at different points of assessment, for example 49 of 58 adolescents had accelerometry data at pre-intervention (details in figure 5.1 in Chapter Five). Underreporting (energy intake: total energy expenditure) was used as a time-varying covariate in the analysis of the self-reported questionnaire data and the dietary intake data from the food records.

Change in eating behaviours and dietary intake analysis: Linear mixed models were used to assess within-person changes in nutrient and eating behaviour outcomes at the time points following conclusion of the eight-week intervention. Models included random intercepts to account for the within-person repeated measures. Slight deviations from normality were accounted for using bootstrapped resampling to estimate standard errors with 1000 replications. Underreporting (EI:TEE) was considered as a potential confounder and the model was adjusted accordingly. To account for differences in the time between assessments, the monthly rate of change during each period was compared. The rate of change was calculated for the waitlist period (baseline to pre-intervention) and compared to the rate of change in outcome variables for all assessment periods between pre-intervention and 12 months post-intervention to assess intervention effectiveness. The analysis was completed using Stata/IC 13.0 for Windows (StataCorp LP, College Station TX, USA) and results were considered statistically significant at p<.05. No adjustment was made for multiple comparisons but 95% confidence intervals and p-values to three decimals places are reported.

6.3 Results
In total, 248 food records were analysed across the 17 month data collection period. Following the intervention, participants increased their intake of fruit and reduced their intake of junk food as measured by three day food records, but vegetable intake did not change significantly (Straker et al., 2014). Mean fruit intake was 0.6 servings (standard error 0.1) per day prior to intervention and increased significantly to 1.1 (0.2) servings per day at post-intervention. Intake of fruit at 12 months post-intervention was 1.0 (0.2) daily serving. For vegetables, daily intake
was 1.3 (0.1) servings at pre- and post-intervention, and 1.4 (0.2) servings at 12 months post-intervention. Junk food intake was 4.6 (0.4) servings per day at pre-intervention and reduced significantly to 3.2 (0.3) servings per day at post-intervention and regressed to 4.3 (0.5) servings per day at 12 months post-intervention. (See Chapter Five for details on fruit, vegetable and junk food servings relating to Study C.)

6.3.1 Adherence to intervention messages
Data from the post-program food records showed 21 out of 35 participants who completed the eight week program adhered to one of the dietary intervention messages by increasing their fruit intake by at least 0.25 of a serve from pre-intervention levels. For vegetables, 17 out of 35 participants who completed the program increased their intake by at least 0.25 of a serve and 24 out of 35 participants reduced their junk food intake by at least 0.5 of a serve. The rate of adherence was reduced at 12 months post-intervention (see figure 6.1).

Of the 24 participants who had complete data at both time points, 13 adhered to the fruit message at post program and 10 adhered at 12 months post program. Similarly, 12 of 24 participants adhered to the vegetable message at post-program and 10 participants adhered at 12 months post-intervention. For junk food, 18 of 24 participants adhered by reducing their junk food intake and 14 adhered at 12 months post-intervention. Adherence to the ‘reduce your junk food intake’ message had the highest proportion of adherence across the measurement period, followed by ‘increase your fruit intake’ and lastly ‘increase your vegetable intake.’
6.3.2 Eating behaviours

The changes in self-reported eating behaviours at each time point and the monthly rate of change over each assessment period can be seen in Table 6.1. As expected, self-reported dietary behaviours were stable during the waitlist period (between baseline and pre-intervention). Significant improvements in frequency of breakfast consumption were reported between pre-intervention and three months post-intervention (estimated change 0.4 points, 95% CI: 0.12, 0.83). Reductions in reported fast food consumption were significantly different to pre-intervention levels at three months (-0.20 points, CI: -0.38, -0.02), six months (-0.24 points, CI: -0.41, -0.06) and 12 months post-intervention (-0.28 points, CI: -0.52, -0.03).

Similarly, the frequency of sugar sweetened beverage consumption was significantly less than pre-intervention at six months (-0.41 points, CI: -0.71, -0.10) and 12 months post-intervention (-0.53 points, CI: -0.91, 0.15). Despite these changes, the monthly rate of change for fast food and sugar sweetened beverage consumption
did not differ from the monthly change observed during the waitlist period. Self-reported changes in fruit and vegetable consumption suggested significant increases in intake at each time point following intervention (see Table 6.1), although no changes were detected in reported junk food intake. The rate of change of consumption measured during the intervention period was significantly different to the waitlist period for fruit (0.17 servings per day/month, CI: 0.06, 0.28) and vegetables (0.25 servings per day/month, CI: 0.07, 0.42). Changes in the frequency of dinner consumption showed a significant monthly improvement between six and 12 months (0.04 points/month, CI: 0.01, 0.07). There were no changes detected for frequency of eating dinner as a family or eating dinner in front of the television.
Table 6.1 Mean self-reported eating behaviour point estimates and rates of change across the study

<table>
<thead>
<tr>
<th></th>
<th>Mean (SE)</th>
<th>Period of change</th>
<th>Mean Δ per month (95% CI)</th>
<th>p-value compared to Baseline to Pre</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency of breakfast</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>3.0 (0.1)</td>
<td>Baseline to Pre</td>
<td>0.03 (-0.13, 0.08)</td>
<td>ref</td>
</tr>
<tr>
<td>Pre</td>
<td>2.9 (0.1)</td>
<td>Baseline to Pre</td>
<td>-0.13 (-0.04, 0.29)</td>
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<tr>
<td>Post</td>
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<td>Pre to Post</td>
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<tr>
<td>3 months</td>
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<td>-0.07 (-0.14, -0.004)</td>
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<td>6 months</td>
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<td>3m to 6m</td>
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<td>.793</td>
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<td>12 months</td>
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<td>6m to 12m</td>
<td>-0.07 (-0.03, 0.08)</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
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<td>.958</td>
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<td><strong>Frequency of dinner</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
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<td>Baseline to Pre</td>
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<td>Post</td>
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<td>Pre to Post</td>
<td>-0.02 (-0.01, 0.00)</td>
<td>.206</td>
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<tr>
<td>3 months</td>
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<td>Post to 3m</td>
<td>-0.05 (-0.21, 0.09)</td>
<td>.444</td>
</tr>
<tr>
<td>6 months</td>
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<td>3m to 6m</td>
<td>-0.02 (-0.07, 0.12)</td>
<td>.378</td>
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<tr>
<td>12 months</td>
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<td>6m to 12m</td>
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<tr>
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</tr>
<tr>
<td><strong>Family dinner</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>3.0 (0.1)</td>
<td>Baseline to Pre</td>
<td>0.02 (-0.07, 0.11)</td>
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<tr>
<td>Pre</td>
<td>3.0 (0.1)</td>
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<td>-0.06 (-0.21, 0.09)</td>
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<td>Post</td>
<td>2.9 (0.1)</td>
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<tr>
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<td>Baseline to Pre</td>
<td>-0.06 (-0.17, 0.05)</td>
<td>ref</td>
</tr>
<tr>
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<td>Baseline to Pre</td>
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<tr>
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<td>.017</td>
</tr>
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<td>.653</td>
</tr>
<tr>
<td>12 months</td>
<td>2.6 (0.1)</td>
<td>6m to 12m</td>
<td>0.01 (-0.04, 0.06)</td>
<td>.250</td>
</tr>
<tr>
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<td>-0.03 (-0.12, 0.06)</td>
<td>.653</td>
</tr>
<tr>
<td><strong>Frequency of fast food</strong></td>
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<td></td>
<td></td>
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<td>Baseline to Pre</td>
<td>-0.01 (-0.06, 0.04)</td>
<td>ref</td>
</tr>
<tr>
<td>Pre</td>
<td>0.5 (0.1)</td>
<td>Baseline to Pre</td>
<td>0.01 (-0.18, 0.19)</td>
<td>.615</td>
</tr>
<tr>
<td>Post</td>
<td>2.5 (0.1)</td>
<td>Pre to Post</td>
<td>-0.05 (-0.19, 0.09)</td>
<td>.920</td>
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<td>3 months</td>
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<td>6 months</td>
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<td>-0.03 (-0.12, 0.06)</td>
<td>.653</td>
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<td>12 months</td>
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<td>6m to 12m</td>
<td>0.01 (-0.04, 0.06)</td>
<td>.250</td>
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<td>Pre to Post</td>
<td>Post to 3m</td>
<td>Post to 3m</td>
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<td>----------------</td>
<td>------</td>
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<td>-------------</td>
</tr>
<tr>
<td>Post 3 months</td>
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<td>-0.05 (-0.15, 0.06)</td>
<td>-0.03 (-0.11, 0.05)</td>
<td>.578</td>
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<tr>
<td>6 months</td>
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<td>-0.01 (-0.08, 0.05)</td>
<td>.972</td>
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<td>12 months</td>
<td>0.3 (0.1)*^</td>
<td>-0.01 (-0.05, 0.04)</td>
<td>.881</td>
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<td>.907</td>
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<td></td>
</tr>
<tr>
<td>Frequency of sweetened beverages</td>
<td>1.5 (0.1)</td>
<td>Baseline to Pre</td>
<td>-0.04 (-0.13, 0.05)</td>
<td>Ref</td>
</tr>
<tr>
<td>Post 3 months</td>
<td>1.1 (0.1)</td>
<td>Pre to Post</td>
<td>-0.14 (-0.03, 0.03)</td>
<td>.353</td>
</tr>
<tr>
<td>6 months</td>
<td>0.9 (0.1)*^</td>
<td>Post to 3m</td>
<td>0.01 (-0.10, 0.12)</td>
<td>.521</td>
</tr>
<tr>
<td>12 months</td>
<td>0.8 (0.1)*^</td>
<td>3m to 6m</td>
<td>-0.06 (-0.17, 0.07)</td>
<td>.800</td>
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<tr>
<td>Maintenance</td>
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<tr>
<td>Perceived daily fruit serves</td>
<td>1.6 (0.1)</td>
<td>Baseline to Pre</td>
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<td>ref</td>
</tr>
<tr>
<td>Post 3 months</td>
<td>1.9 (0.1)*^</td>
<td>Pre to Post</td>
<td>0.17 (0.06, 0.28)</td>
<td>.011</td>
</tr>
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<td>6 months</td>
<td>1.8 (0.1)^</td>
<td>Post to 3m</td>
<td>-0.02 (-0.10, 0.06)</td>
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<td>12 months</td>
<td>1.9 (0.1)^</td>
<td>3m to 6m</td>
<td>-0.01 (-0.09, 0.06)</td>
<td>.785</td>
</tr>
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<td>.476</td>
<td></td>
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<td>Perceived daily vegetable serves</td>
<td>2.5 (0.1)</td>
<td>Baseline to Pre</td>
<td>-0.03 (-0.13, 0.07)</td>
<td>ref</td>
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<tr>
<td>Post 3 months</td>
<td>2.9 (0.1)*^</td>
<td>Pre to Post</td>
<td>0.25 (0.07, 0.42)</td>
<td>.022</td>
</tr>
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<td>6 months</td>
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<td>Post to 3m</td>
<td>0.02 (-0.11, 0.15)</td>
<td>.557</td>
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<td>12 months</td>
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<td>3m to 6m</td>
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<td>.351</td>
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<td>Maintenance</td>
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<td>.348</td>
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<td>Perceived Baseline</td>
<td>1.6 (0.1)</td>
<td>0.03 (-0.01, 0.08)</td>
<td>.272</td>
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</table>
6.3.3 Detailed nutrient intakes

The changes in nutrient intake at each time point and the monthly rate of change over each assessment period can be seen in Table 6.2. During the waitlist period (between baseline and pre-intervention) there were no changes in energy, fat or saturated fat intake. There were also no changes in the percent of energy provided by fat, saturated fat or protein. Intake of key micronutrients (zinc, calcium, iron, vitamin C) did not change over the waitlist period. There was a reported increase in consumption of protein (69.1, SE 1.4 g/day to 74.5, SE 1.8g/day, p= .029), and reduction in consumption of carbohydrates (202.1, SE 3.6 g/day to 188.9, SE 3.9g/day, p= .028) and sugar (88.4, SE 3.5 g/day to 76.2, SE 3.2g/day, p= .018) during the waitlist period. A reduction in the percent total energy provided by carbohydrates was also observed (46.6%, SE 0.6% to 44.6%, SE 0.7%, p=.046).

Following the eight week intervention there was a significant reduction in point estimates of fat (66.0, SE 1.3 g/day to 59.3, SE 1.6g/day, p= .002) and saturated fat consumption (27.5, SE 0.8 g/day to 23.6, SE 0.9g/day, p= .001). The rate of change of fat (-3.3g per day per month, 95%CI: -5.4, -1.2, p=.005) and saturated fat consumption (-2.0g per day per month, 95%CI: -3.1, -0.8, p=.011) was significantly improved from the rate of change during the waitlist period. A reduction in the percent total energy provided by fat (34.8%, SE 0.6% to 31.2%, SE 0.8%, p=<.001) and saturated fat (14.4%, SE 0.3% to 12.3%, SE 0.4%, p=<.001) was also observed, along with a significantly improved monthly rate of change during the intervention period compared to the waitlist period (see Table 6.2). There were no changes in
energy, protein or sugar intake during the intervention. However, point estimates of fibre were significantly increased (15.2, SE 0.5 g/day to 16.8, SE 0.6g/day, \( p = .016 \)) and the monthly rate of change of fibre (0.8g per day per month, 95%CI: 0.1, 1.4, \( p = .017 \)) was significantly greater than that observed during the waitlist period.

During the 12-month maintenance period nutrient intakes appeared to regress towards baseline levels (see Table 6.2). Point estimates of fat and saturated fat between three to 12 months post-intervention were no longer different to pre-intervention levels. The percent energy provided by macronutrients during the maintenance period was not different to pre-intervention distributions. There was a significant increase in the percent of energy provided by fat between post-intervention and three months post-intervention (31.2, SE 0.8% to 33.9 SE 0.8%, \( p = .022 \)) with a significant increase in the monthly rate of change (\( p = .002 \)). Total carbohydrate intake did remain lower than pre-intervention levels throughout the 12 month maintenance period and fibre intake remained significantly higher than pre-intervention levels (see Table 6.2). Energy, protein and sugar intake did not change during the maintenance period, nor did intakes of calcium, zinc or Vitamin C.
Table 6.2 Mean nutrient intake point estimates and rates of change across the study

<table>
<thead>
<tr>
<th></th>
<th>Mean (SE)*</th>
<th>Period of change</th>
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<th>p-value compared to Baseline to Pre</th>
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<tr>
<td>Baseline</td>
<td>6969 (46.9)</td>
<td>Baseline to Pre</td>
<td>1.0 (-50.5, 52.4)</td>
<td>ref</td>
</tr>
<tr>
<td>Pre</td>
<td>6972 (50.8)</td>
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<tr>
<td>Post</td>
<td>6965 (60.0)</td>
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**kJ from sat fat**

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**kJ from carb**

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**Calcium**

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*difference from baseline (p<.05) ^difference from pre (p<.05)

Maintenance: The period between post-intervention and 12 months post-intervention

n=61

### 6.4 Discussion

This study provides unique data on adherence to the dietary component of a multi-component intervention in obese adolescents. It is one of the few adolescent intervention studies to consider eating behaviour and dietary intake changes in the 12 month period following intervention.
6.4.1 Key findings

The key findings from this study showed that more than half of participants adhered to the key dietary intervention messages about increasing intake of fruit and vegetables and reducing intake of junk food. ‘Eat more vegetables’ was the message least adhered to and ‘eat less junk food’ was the message most adhered to. Adherence to the fruit, vegetable and junk food intervention messages reduced over time following the intervention (see Figure 6.1). Eating behaviours, as measured by the short eating behaviour questionnaire did not change significantly during the intervention. There were some changes in self-reported eating behaviours during the maintenance period including increased consumption of breakfast and reduced consumption of fast food and sugar sweetened beverages. During the intervention energy intake did not change but nutrient changes included reductions in fat and saturated fat, along with an increase in fibre. During the maintenance period, energy intake remained stable but fat and saturated fat intake gradually returned to baseline levels over the 12 months. In summary, adherence measures showed that a large proportion of participants adhered to the key components of the dietary intervention, with modest dietary changes seen following intervention and lessening over time.

6.4.2 Adherence

There is a lack of current studies to incorporate any measures of adherence to dietary interventions in overweight adolescents (Ho et al., 2013). Further, no guidelines exist regarding the best way to measure or report dietary adherence in intervention studies (Vitolins et al., 2000). This gap has begun to be addressed in this study by using data from detailed food records to measure adherence to the CAFAP dietary intervention messages. Given the lack of previous reporting of adherence in overweight adolescent interventions, the methods used have been developed to suit the study. At baseline, the dietary intake of participants diverged markedly from dietary guidelines, so an adherence measure based on achieving these dietary guidelines was not likely to be sensitive to any small-moderate changes made following intervention. Instead, adherence to the key intervention messages was considered to be achieved if the participants increased their intake of fruits and vegetables by at least 0.25 servings and reduced their intake of junk foods...
by at least 0.5 servings. There is no accepted definition of a clinically important change in servings of key food groups; however, these figures represented at least a 10% change in intakes from baseline levels. This also reflects the magnitude of expected outcomes described in the CAFAP protocol paper (Straker et al., 2012) and may be useful as a threshold to measure adherence to dietary change messages in future interventions. The interpretation of the adherence levels is further limited by the lack of evidence regarding what constitutes satisfactory levels of adherence. Previous studies have identified a range of 80-120% of recommended intake as an indicator of adherence (Foraker et al., 2014). This method was not appropriate in the current study, given that adolescents were encouraged to improve their intake rather than achieve ideal but perhaps unrealistic diet goals. Other methods from previous research measuring dichotomous variables were not applicable due to the multi-factorial nature of diet. Thus, the adherence reported in this paper relates to the proportion of participants who have adhered to the different dietary change messages. Future interventions can compare their findings to these levels of adherence and build towards a clear consensus for acceptable levels of adherence to dietary interventions based on observed changes in health status.

6.4.3 Eating behaviours

The findings described in this paper add to the current small body of evidence around eating behaviour changes in obese adolescents following intervention. CAFAP participants reported changes in line with prior studies of overweight adolescents, in both fast food intake (DeBar et al., 2012) and SSB intake (Tsiros et al., 2008). Whilst these behaviour changes remained significant for CAFAP participants during the maintenance period, comparisons of sustained change are limited as no other studies have reported general eating behaviour changes for at least 12 months following intervention. The only other study to have reported long-term changes did not report behaviours associated with weight gain, instead reporting on food frequency questionnaire data such as reduced intake of high fat meat products to once a week or less (Nguyen et al., 2012b). Thus, the CAFAP findings add much-needed data to the limited evidence base around overweight
adolescent eating behaviours, and provide an example of how these may change following intervention.

6.4.4 Nutrient intakes
Nutrient intakes for overweight adolescents have also not been well-described in the literature. The gradual pattern for macronutrient intake levels to regress towards baseline intake levels over the 12 month maintenance period may reflect the waning adherence to CAFAP nutrition intervention messages. This was also reflected in the regression of physical activity changes (Straker et al., 2014). The loss of changes occurred alongside the tapering maintenance support provided to adolescents, which was not well-received in the initial three months post-intervention (Smith et al., 2014b). This might suggest that future programs would benefit from more intensive support over 12 months, possibly using a mode of contact other than text messaging. Despite a loss of positive changes in macronutrient intakes during the maintenance period, these levels did not worsen from baseline levels. Further, findings showed micronutrient levels did not change throughout the study. These two factors suggest that CAFAP did not have a deleterious effect on nutritional intake throughout the study period. This is particularly important given the importance of adequate nutrition to support growth and development during adolescence (Stang, 2010). Similar results have been found in other studies with some measure of nutrient intake, with no reductions in key nutrients following intervention (Tsiros et al., 2008, Bean et al., 2011, Ball et al., 2011). Calcium intake, important for growth and development, was particularly low throughout the current study (~600-650mg), which is similar to the calcium intake of 727mg reported by Bean et al. (2011). Intakes of calcium among the general Australian adolescent population have been estimated at about 988mg, which is also lower than the estimated average requirement of 1050mg for adolescents (Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008, National Health and Medical Research Council, 2006). This might suggest an important potential target for future dietary interventions for adolescents.

The modest dietary changes observed in this study reflect the current evidence from obesity interventions. CAFAP participants reported no changes in total energy
intake compared to the waitlist control period, reflecting other recent trials where
ergy intake did not differ from the control comparison (Janicke et al., 2008a,
Davis et al., 2011, Park et al., 2007, Saelens et al., 2002, Tsiros et al., 2008). Bean et
al. (2011) demonstrated significant reductions in adolescent energy, fat and
saturated fat consumption immediately post-intervention, but did not include any
control group or waitlist comparison. Shaibi et al. (2012) also reported a significant
reduction in adolescent total fat intake but used a brief questionnaire not yet
validated in adolescents. Neither of these studies adjusted for underreporting and
neither showed a reduction in percent of total energy provided by fat as CAFAP did,
which is thought to be a more reliable measure than absolute fat intake (Hirvonen
et al., 1997). Davis et al. (2009b) reported significant reductions in total sugar intake
in one of two intervention groups immediately post-intervention, although these
results may not be generalizable given both groups had received the same nutrition
component of the intervention. There were no changes in reported sugar
consumption following the CAFAP intervention.

6.4.5 Influences on dietary behaviour change
In this study, the primary outcomes and intervention messages were based on
behaviour change rather than change in BMI, because improvements in measures
such as diet quality have been shown to produce favourable changes on biomedical
outcomes including insulin action and blood lipid levels irrespective of weight loss
(Gaesser et al., 2011). Behaviour change as a result of the CAFAP dietary
intervention was assessed by adherence to the CAFAP dietary intervention
messages. It was hypothesised that targeting and improving key theoretical
constructs, such as motivation and parent support, would lead to dietary behaviour
change (Kristal and Ollberding, 2013) based on self-determination and goal setting
theories (Fenner et al., 2013). However, exploratory post hoc analysis did not
support this relationship (see Appendix P). When autonomous motivation for
healthy eating and perceived parental support for healthy eating were compared
between those who adhered to key dietary messages and those did not adhere,
there were no significant differences between those groups at either post-
intervention or 12-months post-intervention. Due to the limited sample size, it was
not possible to complete a full mediation analysis; however, future research should include mediation analyses of the theoretical constructs to help explain the mechanisms for successful behaviour change.

6.4.6 Importance of focussing on dietary behaviours
The poor health trajectory of obese adolescents and generally modest outcomes of interventions (Oude Luttikhuis et al., 2009) highlight the need for programs to help participants to develop long-lasting and sustainable behaviour change. Although there were only modest improvements noted in BMI (Straker et al., 2014), positive changes reported in dietary behaviours such as reduced fast food consumption and increased consumption of breakfast may play an important role in long-term obesity management and have the potential to independently prevent the development of other chronic diseases (World Cancer Research Fund/American Institute for Cancer Research, 2007). Additionally, dietary behaviour is only one component of the energy balance equation and interventions for obesity must also address physical activity and sedentary behaviour levels. The encouraging results of the current study of dietary behaviours support a focus on behaviour change (e.g. reduction in fast food intake) rather than weight loss in adolescents, and may provide long-lasting health benefits in this group. Based on the findings of this study, potential future changes to CAFAP could include further opportunities to enjoy tasting fruits and vegetables (Brug et al., 2008) to increase consumption levels, and a greater focus on dairy foods in light of the suboptimal calcium intakes reported.

6.4.7 Dietary assessment methods
In this study, adolescents rated their own intake of fruits and vegetables differently using the short food behaviour questionnaire compared to how they recorded their intake using a three day food record. Despite the reducing levels of adherence and modest changes in diet as shown by the food records, the estimates of fruit and vegetable intake from the eating behaviour questionnaire remained significantly increased following intervention for the entire 12 month maintenance period. The magnitude of change was also larger in the questionnaire data. For example, the food records showed no change in vegetable intake following intervention but the
short questionnaire showed an increase in vegetable intake during the maintenance period of up to 0.9 serves at 12 months post-intervention. In this study, there were a number of reasons to have confidence in the findings from the food records, as discussed below. Thus, it seems that the eating behaviour questionnaire may have overestimated the effect of the intervention on intakes, particularly of vegetables. This discrepancy may be due to a desire to report socially acceptable intakes in line with the CAFAP key messages (Miller et al., 2008), particularly given that all changes occurred after the intervention had been delivered. The wording of the questions directly reflect the dietary intervention messages, so adolescents may have felt obliged to show they had adhered. Alternatively the participants perception may have been that they were eating more healthfully. The differences in self-reported behaviours from questionnaire and self-reported intake from food records highlight the inherent difficulties in obtaining consistent and accurate dietary data in this population. Aside from the limitations associated with any assessment of self-reported diet, other limitations included a relatively small sample size at 12 months, although the attrition rate reflects other recent paediatric weight management literature (Skelton and Beech, 2011). The proportionately low numbers of male participants in this study reduces the generalizability of these findings. Additional studies are needed to replicate these findings in diverse populations.

6.4.8 Strengths and limitations
The strengths of the study include the use of multiple dietary assessment measures, adjustments for the impact of underreporting, detailed description of obese adolescent dietary change following intervention and detailed maintenance dietary data for a further 12 months. Collecting high quality dietary data from obese adolescents presents unique challenges, particularly to identify and minimise the impact of underreporting (Collins et al., 2007, Livingstone and Robson, 2000). Underreporting is an inherent issue with all self-reported dietary measures, and will remain a challenge in the absence of an objective, field-based measure of intake to use in intervention studies (Livingstone and Robson, 2000). Despite a number of proposed methods of assessing misreporting in dietary data (Goldberg et al., 1991, Tooze et al., 2012, McCrory et al., 2002, Huang et al., 2005), no standardised way
has been accepted for screening out implausible reporters from intervention studies and many studies fail to address the issue. Three day food records have known limitations with underreporting but were used in this study to provide information about consumption patterns, including timing of meals (Smith et al., 2014c), without being limited by extensive reliance on memory and time available at physical assessment. In this study we have successfully used underreporting as a covariate to control for the effect of underreporting on the dietary outcomes, giving greater confidence in the results.

6.5 Conclusions
This is one of the first studies to report overweight and obese adolescent adherence to the dietary component of a multi-component lifestyle intervention. Findings showed that adherence rates were highest for CAFAP messages about reducing junk food. Overweight and obese adolescents who participated in CAFAP reported modest improvements in some key eating behaviours and nutrient intakes, although this differed between methods of dietary assessment. Future studies with overweight and obese adolescents should report adherence to dietary interventions and use standardised and practical methods for assessing and controlling for underreporting. These data provide evidence to support the call for more comprehensive and long-term reporting of dietary intake in obese adolescent interventions to better understand dietary change in this group and thus guide the design of effective interventions.
Chapter 7.0  Study E: Text messaging to support behaviour change

The information in this chapter is an abridged version of the full paper published in the Journal of Medical Internet Research as:


Adolescents are considered a hard to reach group and novel approaches are needed to encourage good health. Text messaging interventions have been reported as acceptable to adolescents but there is little evidence regarding the use of text messages with overweight and obese adolescents to support engagement or behaviour change after the conclusion of a healthy lifestyle program.

The intent of this study was to explore the opinions of overweight adolescents and their parents regarding the use of text messages as a support during the maintenance period following an intervention.

This paper reports on the findings from focus groups conducted with adolescents (n=12) and parents (n=13) who had completed an eight-week intensive intervention known as Curtin University’s Activity, Food and Attitudes Program (CAFAP). Focus groups were conducted three months post intensive intervention. Participants were asked about their experiences of the prior three month maintenance phase during which adolescents had received tri-weekly text messages based on self-determination theory and goal setting theory. Participants were asked about the style and content of text messages used as well as how they used the text messages. Data were analysed using content and thematic analyses.

Two clear themes emerged from the focus groups relating to (1) what adolescents liked or thought they wanted in a text message to support behaviour change, and (2) how they experienced or responded to text
messages. Within the “like/want” theme, there were five sub-themes relating to the overall tone of the text, frequency, timing, reference to long-term goals, and inclusion of practical tips. Within the “response to text” theme, there were four sub-themes describing a lack of motivation, barriers to change, feelings of shame and perceived unfavourable comparison with other adolescents. What adolescents said they wanted in text messages often conflicted with their actual experiences. Parent reports provided a useful secondary view of adolescent experience.

The conflicting views described in this study suggest that overweight and obese adolescents may not know or have the ability to articulate how they would best be supported with text messages during a healthy lifestyle maintenance phase. Further, supporting both engagement and behaviour change simultaneously with text messaging may not be possible. Intervention texts should be personalised as much as possible and minimise feelings of guilt and shame in overweight and obese adolescents. Future research with text messaging for overweight and obese adolescents should incorporate clear intervention aims and evaluation methods specifically related to adolescent engagement or behaviour change.

7.1 Introduction

7.1.1 Use of text messaging with adolescents

The provision of effective health-related interventions for adolescents is a difficult task, particularly when traditional methods of communication are unlikely to be engaging (Steinbeck et al., 2009). Current mobile telephone usage trends show adolescents are increasingly using text messaging as a preferred method of communication (Lenhart, 2012). Text messaging, also known as Short Message Service (SMS), may therefore provide an acceptable means of delivering health messages in adolescent populations (Franklin et al., 2003, Woolford et al., 2010, Shapiro et al., 2008, de Niet et al., 2012b).
In adolescent weight management programs, text messaging shows promise as a feasible and acceptable method of communication (Woolford et al., 2010, Kornman et al., 2010). Evidence from healthy weight adolescent groups support this concept of “acceptability” (Hingle et al., 2013), yet it remains unknown whether text messaging is an effective means for fostering engagement or supporting behaviour change.

### 7.1.2 Text messaging to support engagement

Given the significant dropout rates reported in paediatric weight management programs (Skelton and Beech, 2011) and lack of evidence for long-term weight maintenance in adolescence (Butryn et al., 2010), there is much to be gained from developing an effective method for keeping participants engaged with a program. Text messaging may be a useful way of maintaining this engagement. de Niet et al. (2012b) found that children and adolescents randomised to a text message treatment group were 3.5 times less likely than the control group to drop out of the maintenance period of a healthy lifestyle intervention but also showed that text message engagement declined over the 9-month period. Older pre-adolescent children (12 year olds sent 0.5 texts per week) were less likely to send responses compared with younger children (7 year olds sent 0.8 texts per week) (de Niet et al., 2012b). This decline in adherence to monitoring over time has been documented previously (Carter et al., 2013), but adherence remains higher than other traditional methods of self-monitoring. Kornman et al. (2010) described only a modest level of adolescent engagement with their text messaging and email adjunct to the Loozit program, with adolescents responding to 22.0% of text messages over a 10-month maintenance period. The authors found that text messages asking for a response had more replies and text messages had a more immediate response than the emails. Whether text messaging can be used to maintain engagement of overweight adolescents in a healthy lifestyle program remains unclear.

### 7.1.3 Text messaging to support behaviour change

Studies evaluating the effectiveness of text messages offer inconsistent support for the use of text messaging to support behaviour change and/or weight maintenance (Sirriyeh et al., 2010, Franklin et al., 2006, Shrewsbury et al., 2010, Nguyen et al.,
Adolescents in the Loozit program rated the text message support during the 10-month maintenance period as “somewhat helpful”; however, the results suggested that the use of text messages developed for this intervention did not have a significant effect on primary outcomes at 12 or 24 months post program (Kornman et al., 2010, Nguyen et al., 2012b, Nguyen et al., 2013). Other short-term studies assessing the effectiveness of text messaging interventions with adolescents suggest success only in those who had not previously engaged in the targeted behaviours before the intervention commenced (Sirriyeh et al., 2010) or who received additional intensive support (ie, intensive insulin therapy) in addition to text messages (Franklin et al., 2006). There remains a gap in the evidence regarding the effectiveness of text messaging interventions to support behaviour change in overweight and obese adolescents.

### 7.1.4 Text message development

There is also limited evidence regarding the best way to construct and send text messages for use with adolescents (Woolford et al., 2011a). Factors to consider include the message tone, content and length, as well as the timing and frequency of text message delivery. Several studies have reported the wording and timing of delivered messages (Franklin et al., 2003, de Niet et al., 2012b, Kornman et al., 2010, Sirriyeh et al., 2010), but only two studies have considered the format of text messages to be sent regularly to support behaviour change in adolescents (Hingle et al., 2013) or obese adolescents (Woolford et al., 2011a). Rigorous pilot testing of text messages has provided descriptions of what adolescents think they want (Hingle et al., 2013, Woolford et al., 2011a), but whether adolescents actually do know and can articulate what they want in text messages and whether this is desirable for either engagement or intervention efficacy is unknown. There are currently no studies that have completed a detailed post-intervention evaluation of overweight and obese adolescent experiences of text messages, including perceptions of content, style, or usefulness. A lack of synchrony between what adolescents think they want and may actually like or find useful is suggested by evidence that overweight teenagers have indicated a strong preference for directive
text messages, which seems to contradict their desire for autonomy (Woolford et al., 2011a).

7.1.5 Parent role in text messaging interventions
Parents have not traditionally been involved in the development or refinement of text messaging interventions for adolescents. However, parents may play an important role in supporting adolescent engagement in research (Steinbeck et al., 2009), providing healthful environments (Pearson et al., 2009b), modelling healthy behaviours (Hanson et al., 2005), and supporting adolescent behaviour change (Fenner et al., 2013). The potential for parents to offer valuable insight into adolescent experiences of text messaging interventions warrants exploration.

7.1.6 Aim
Current recommendations for research into text messaging interventions advise researchers to design their study with a strong theoretical foundation (Fjeldsoe et al., 2009, Militello et al., 2012) and report on process evaluation after the intervention, to inform others about the best way to structure text messages, and effectively utilise this form of communication with adolescents (Kornman et al., 2010, Woolford et al., 2011a, Fjeldsoe et al., 2009, de Niet et al., 2012a). Therefore, the aim of this study was to explore opinions of overweight and obese adolescents and their parents, who have participated in a multi-disciplinary healthy lifestyle program, regarding the use of text messages as a support during the maintenance period.

7.2 Method

7.2.1 Study design
This study relates to focus groups held during the maintenance phase of a multi-disciplinary healthy lifestyle program for overweight and obese adolescents aged 12-16 years and their parents. A wait-list controlled trial of Curtin University’s Activity, Food and Attitudes Program (CAFAP) has been conducted and is described elsewhere (Straker et al., 2012) along with its theoretical underpinnings (Fenner et al., 2013). Briefly, participants enrolled in CAFAP and were placed on a three-month waiting list to allow for a control period. Following this waiting list period,
adolescents and parents completed the intensive phase of the program, involving twice-weekly group sessions for eight weeks. Sessions covered healthy eating, increasing physical activity, reducing sedentary behaviour, and setting goals for healthy behaviour change. Parents were also trained in behaviours around need-satisfaction and goal setting to support their adolescent’s lifestyle changes (Fenner et al., 2013). The intensive phase was followed by a tapered maintenance phase over 12 months. The first three months of the maintenance phase were considered to be “high intensity” where adolescents received three text messages per week and one phone coaching session every two weeks. The next three-month period included a tapering of contact to “medium intensity”, where adolescents received a weekly text message and a monthly phone coaching session. The “low intensity” phase of the maintenance period occurred between six and 12 months post intensive program and included monthly text messages and quarterly phone coaching sessions. This study was approved by the Curtin University Human Research Ethics Committee (HR105/2011).

This qualitative study was performed three months after the eight-week intervention period of CAFAP, which coincided with the conclusion of the high intensity maintenance period. The intent of the study was to explore adolescents’ perceptions of text messages received, in combination with the observations and experiences of the parents during the previous three months. Four focus groups were conducted with overweight and obese adolescents between September 2012 and April 2013 to cover the three waves of participants who completed the program at different times. Four focus groups were also completed by the parents of these adolescents. Focus groups were small (three to four adolescents) to encourage rich discussion of the text messages.

### 7.2.2 Recruitment

Three months after completion of the intensive face-to-face CAFAP sessions, adolescents from each wave were invited by flyer, email, and text message to participate in a 60-minute focus group. Adolescents were offered a $30AUD gift voucher for participating in the focus group. Of the 35 adolescents invited, 16
agreed to participate and 12 attended the focus groups. Parents were recruited once their adolescent had agreed to participate in the focus group. All adolescents had a parent participate in the focus groups at the same time as they completed their own focus group.

7.2.3 Text message development and programming

CAFAP used an automated text messaging system to send predetermined but semi-tailored text messages to adolescents. During the first three months of the 12-month maintenance period, adolescents were sent a text message at 6pm on two weekdays and noon on one weekend day. The timing and frequency of text messages in this study was chosen as it reflected a midway point between previous adolescent trials (Kornman et al., 2010, Franklin et al., 2006) and incorporated evidence from associated formative research (Smith et al., 2014a). Adolescents chose the days that would best suit them at the conclusion of the intensive intervention phase. Two versions of the message plan were developed using the same text messages but in a different order to ensure that adolescents who were close friends would receive different messages. Texts were limited to 320 characters minus auto text (“Hi [first name], [text message], from the CAFAP Team”). Texts were sent to the adolescent’s personal phone in most instances, except where the adolescent did not have a personal phone or did not use it consistently. Some families requested the text also be sent to a parent’s phone to keep the parent involved. If text messages were not able to be delivered, research staff would follow up to manually send the text or contact the participant by phone if the text remained undelivered.

The contact during the maintenance period continued with the same theoretical base and key messages as during the intensive face-to-face contact period. Text contact was thus based on self-determination theory (Deci and Ryan, 2000) and goal setting theory (Locke and Latham, 1990) and focused on eating more fruit and vegetables, eating less junk food, being less sedentary and being more physically active (Fenner et al., 2013, Straker et al., 2012). Message development also incorporated recommendations from current literature, by including a positive tone
(de Niet et al., 2012b, Woolford et al., 2011a, de Niet et al., 2012a) and friendly but professional language (Woolford et al., 2011a). Messages were constructed so as to be perceived as deriving from the research team (Kornman et al., 2010, Woolford et al., 2011a) and were semi-tailored (Mauriello et al., 2010) by using first names and references to CAFAP or past text message contact (Woolford et al., 2010, Shapiro et al., 2008, de Niet et al., 2012b, Kornman et al., 2010, Franklin et al., 2006, Woolford et al., 2011a, Fjeldsoe et al., 2009). The word “you” was frequently used to make facts relatable to adolescents (Hingle et al., 2013) and a maximum of two reflective questions were included in each message (Woolford et al., 2011a). Messages that provided options for behaviours were always framed to give adolescents a choice (e.g., “You might like to...”) and recipes or testimonials from other teenagers (e.g., “Other teens have found it helpful to...”) were used to enhance self-efficacy (Woolford et al., 2011a). Suggestions for activities were based on affective beliefs to emphasise the enjoyment and social nature of participation (Sirriyeh et al., 2010) and reaffirmed the benefits of healthy eating and physical activity. Negative wording or the mention of triggers for unhealthy behaviours (e.g., consumption of junk food) was avoided (Woolford et al., 2011a). Adolescents were able to reply to text messages and receive a response, but were not expressly asked to reply. This approach was chosen to align with the theoretical underpinnings of text message development relating to fostering a sense of autonomy (Fenner et al., 2013, Deci and Ryan, 2000) and formative work suggesting adolescents may be reluctant to spend their own money on responses (Smith et al., 2014a). Text messages were designed to prompt behaviours and offer adolescents options for healthy behaviours, but they did not have to act on the texts if that was not their choice. The number of text messages sent to adolescents was measured on the SMS database. Five overall categories of texts were developed (general, goal setting, healthy eating, physical activity, and sedentary behaviour) with messages tailored for weekday evenings and weekends. See Appendix Q for examples of CAFAP text messages.
7.2.4 Focus group protocol

Facilitators had completed formal training with a qualitative research expert covering focus group conduct prior to involvement in these focus groups and had prior experience in conducting focus groups with similar participants.

7.2.4.1 Adolescent focus groups

Adolescent focus groups were 60 minutes long and conducted by one author (KS). Each focus group was audiotaped with participant consent. In the adolescent groups, actual text messages were used to guide the discussion at the start of the focus group based on the work of Woolford et al. and previous difficulties noted by the research team when adolescents were asked to answer questions that required them to reflect on their experiences. Six messages were chosen from the database of texts sent during the high intensity maintenance phase to reflect the different content and key strategies used in the main text categories as outlined below in Table 7.1, with full schedule provided in Appendix R.
Table 7.1 Text message examples used to represent the content of text messages used in the intervention and typical adolescent responses from focus groups

<table>
<thead>
<tr>
<th>Category</th>
<th>Text message</th>
<th>Key strategies</th>
<th>Examples of adolescent responsesa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy eating</td>
<td>After dinner can be a good time to eat some fruit. If you had less than 2 bits of fruit today, you might like some tinned apricots &amp; yoghurt for dessert?</td>
<td>Message including a ‘helpful tip’</td>
<td><em>I liked it except I didn’t have any of that stuff.</em> [Adolescent 10 (A10)]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>I’d prefer if you told me to have strawberries.</em> [A12]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>It’s ok but I don’t really eat after dinner.</em> [A4]</td>
</tr>
<tr>
<td>Sedentary behaviour</td>
<td>A CAFAP teen has found using an egg-timer is a good way of knowing it’s time for an active break after playing on the computer for 30 mins. You could choose to try it too.</td>
<td>Testimonial message</td>
<td><em>Most probably wouldn’t influence my behaviour because, I don’t know, I get addicted to my computer.</em> [A3]</td>
</tr>
<tr>
<td>Physical activity</td>
<td>What are the reasons you want to be more active? You might like to think about these when the going gets tough!</td>
<td>Intrinsic motivation, reflecting goal setting process used during the program</td>
<td><em>It makes you actually think about it. You have it there but you don’t actually think about it.</em> [A7]</td>
</tr>
<tr>
<td>Physical activity</td>
<td>How many steps have you done today? How about trying to do a few extra thousand steps this afternoon?</td>
<td>Reflective questioning</td>
<td><em>There’s nothing wrong with it, but like saying a few extra thousand like is too much.</em> [A5]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>It would make you think about doing more steps.</em> [A1]</td>
</tr>
<tr>
<td>Goal setting</td>
<td>Have a look at your goals for physical activity, sedentary behaviour and healthy eating. Plan something fun to do this weekend to help meet your goals.</td>
<td>Bigger picture, reinforcing key CAFAP areas and goal setting.</td>
<td><em>I have homework on the weekend, like every day... If I’m not doing homework I’m sleeping. Like pretty much.</em> [A11]</td>
</tr>
</tbody>
</table>
Healthy eating  | How many bits of junk food have you had today? You could challenge yourself to see if you can go the rest of the day without any junk food. Some cut up fruit might be a sweet treat instead!
---|---
Reflective questioning and ‘helpful tip’  | I felt really guilty because I think I’d had ummm I’d had something, maybe a donut for breakfast. [A2]

*Adolescents were assigned a code to distinguish between responders. The code ranges from A1-A12.

The aim of using these six text messages was to explore the adolescents’ response to the message content. For each of the six messages, adolescents were asked:

- Did you like/dislike this message?
- What would you first think when you got this message?
- Is it a realistic message for you? (Is it right for you?)
- What’s good about it?
- What’s not so good about it?
- Did it make you think about changing your behaviour (diet/activity/habit)?
- How could we make it better?

For the second part of the focus group, adolescents were asked about another six text messages (see Table 2) to understand their responses to the specific strategies used in the messages. The final part of the focus group included questions about general responses, timing, and how the text messages were used by adolescents.
Table 7.2 Text message examples used to represent the style of text messages sent in the high intensity maintenance period.

<table>
<thead>
<tr>
<th>Question to adolescents</th>
<th>Example text message</th>
<th>Examples of adolescent responses¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>What did you think of messages that asked you a question?</td>
<td>What was your sedentary behaviour goal for today? Did you achieve your goal?</td>
<td>For Monday to Fridays, it’s a bit hard because we have loads of double periods...and we’re sitting down for long periods of time so we’ve kinda destroyed our sedentary goal. [Adolescent 12 (A12)]</td>
</tr>
<tr>
<td>What did you think of messages that reminded you about why being healthy was important?</td>
<td>Do you remember that the benefits of being more active include having a healthier heart and body chemistry, feeling less tired, sleeping better, being happier and thinking better?</td>
<td>Yeah. It helps you because it asks you a question but it instantly answers it for you. [A4]  It’s good to remember. Feeling less tired would be good. [A2]</td>
</tr>
<tr>
<td>What did you think of the ‘big picture’ messages</td>
<td>Remember the key messages of CAFAP are: eat more fruit and veg, eat less junk food, be less inactive and be more active.</td>
<td>It actually like reminds you that you’re like on Earth and you’re sitting there playing video games...And I’ve gotta like do stuff and be proactive like normal people. [A9]</td>
</tr>
<tr>
<td>What did you think of the messages that gave you healthy tips?</td>
<td>Think about how many vegies u had today. If u had less than your goal, try to add in 1 more piece tomorrow. How about some vegie sticks with one of</td>
<td>It was helpful. I often followed the tips. [A8]  I found it good because I wouldn’t think of something like that. [A6]</td>
</tr>
</tbody>
</table>
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| What did you think of the messages that included ideas from other teenagers? | Some teenagers have told us that cut up fruit salad for recess helps them reach their healthy eating goals. What about taking some tomorrow? | These sound like healthy teenagers and sometimes I get a bit annoyed because I’m jealous. They have a better state of mind than me. [A4] |
| What do you think about messages that are about what not to do? | Don’t eat junk food today or don’t spend the afternoon lying on the couch. b | If you tell someone not to do something, they’re just going to do it, everyone knows that. [A5] |

aAdolescents were assigned a code to distinguish between responders. The code ranges from A1-A12.
bThis text message was created to be tested in the focus groups based on current literature [17] but was not actually used in the intervention.

### 7.2.4.2 Parent focus groups

Parent groups were also 60 minutes long, conducted by one of two authors (LS or AF) and audiotaped with participant consent. This secondary view from parents is potentially helpful to attempt to validate the information provided by adolescents, particularly from interviews or focus groups where there is potential for participants to express a more socially acceptable view and obscure their true opinions. The group was asked three main questions regarding the experiences of their family in the previous three months, their opinions on the usefulness of the text message support, and any suggestions to better support adolescents after completion of the intensive eight-week program.

### 7.2.5 Data analysis

Following focus group discussions, responses to questions were transcribed verbatim by KS, with confidentiality ensured by coding of transcripts with subject identifier codes. The data was sorted and coded and assigned to categories based on similar phrases and topics. Coding was completed separately by two authors (KS and DK), with peer review checks by LS and AF to ensure the overall credibility of
findings and interpretations (Gliner, 1994). Initial thematic analysis was based on the structure of the research questions (Broom, 2005) to identify theoretical constructs that described the experience of adolescents and parents. Themes were allowed to emerge using a mostly inductive approach (Broom, 2005). Differences in interpretation were resolved by consensus. Underlying similarities and differences were evaluated and used to form the fundamental impression of the focus group discussions (Polgar and Thomas, 1995). The data were triangulated with adolescent and parent interpretations compared [31] to give greater context to the data. By comparing and contrasting results from two groups with different viewpoints, we attempted to overcome the intrinsic biases associated with single group observations and explain the situation more fully (Cohen et al., 2007). Categories were amalgamated using Microsoft Excel and the major themes detailed using description and quotes from participants to support these findings (Gliner, 1994).

7.3 Results

7.3.1 Demographics

Twelve adolescents with a mean BMI (body mass index) $z$-score of 2.05 (SD 0.35) participated in the focus groups. The mean age of the adolescent participants was 14.3 (SD 1.5) years, with females overrepresented (92%, 11/12) when compared to all CAFAP participants who participated in the text message intervention (77% female, 33/43). A total of 13 parents, including 12 mothers and one father, participated in the parent focus groups. The majority of participants were white Australians from middle-low socioeconomic areas. Details regarding household characteristics were not further explored. The focus group participants included adolescents who had varying levels of success in adopting healthy behaviours at the three-month assessment and were likely a good representation of the overall group.

7.3.2 Text message descriptive statistics

In this intervention, 37% (16/43) of adolescents did not have access to their own phone regularly and had the text messages sent to their parent’s phone. These
adolescents made up 33% (4/12) of the focus group participants. Of the parents, 60% (26/43) of parents in the intervention received a copy of the text messages, which included some parents of adolescents who had their own phone. A total of 2240 text messages were sent to adolescents (not including additional messages sent to parents only), eliciting 152 replies at a response rate of 6.8%.

7.3.3 Participant opinions
All attendees were generous with their feedback and engaged meaningfully in the discussions. Two distinct themes emerged from the adolescent and parent discussions relating to (1) what adolescents liked or thought they wanted in a text message to support behaviour change, and (2) how they experienced or responded to text messages. Within the “like/want” theme, there were five sub-themes relating to the overall tone of the text, frequency, timing, reference to long-term goals, and inclusion of practical tips. Within the “response to text” theme, there were four sub-themes describing a lack of motivation, barriers to change, feelings of shame, and perceived unfavourable comparison with other adolescents. Themes are described and supported with quotes from adolescents (A) and parents (P) below.

7.3.3.1 More casual and personalised text messages are preferred
Adolescents were unanimous in their reaction to the tone of the texts, highlighting a need to make the messages less formal and more relatable to them. Parents expressed a similar view, indicating that the tone of the messages needed to be more personal.

More smiley faces. Smiley faces are good. [A1]

They’re really proper. You need to abbreviate and stuff. Make it seem more human. [A3]

They sound a bit rehearsed at times. A bit impersonal. Sometimes more casual...instead of Hi XX, it could be like Hey or Hey XX. More chatty. Because the ones that were being sent sound like for an adult. They’re too formal. [A5]
Yes- make ‘em more 21st century. [A4]

Make them custom for each person, because each person does a different amount of each thing...So for the stuff that we already do, the text messages should be like different for everyone. [A9]

The SMS were too impersonal. It was like it was coming from a machine. [P7]

7.3.3.2 Tri-weekly text messages were too frequent
Adolescents and parents all agreed that the messages were sent too frequently and as a result the reaction to the texts became increasingly negative over time.

If it had been say one a whole week, say on a Wednesday because that’s the middle of the week, to see how you’re going but to help as well, that’d be good. But three continuous in a week, that’s just like Shut Up! [A5]

It’s just another form of nagging to them. [P7]

They kept on coming. Like why can’t you let us do what we’re doing and then we tell you eventually when we come back. [A4]

I know the messages got to a stage where, it’s almost like she would duck. [P10]

With the messages, she was fine with them to begin with, but after that she only wanted to know about a few. [P6]

Towards the end I would see CAFAP and put it to one side. [A2]

7.3.3.3 Lack of consistent response on the best time to receive messages
Adolescent views varied regarding the best time to receive text messages, although most thought the timing needed to be specific for each individual.

7 o’clock in the morning would be better for me because it’s just before I go to school. It’s when you check your phone. [A8]
No, no, no, no, no. If you text messaged me before school I would absolutely call you and go off at you because you ain’t texting me before school. I am a bad morning person and getting a text message from CAFAP would just blow it. It’s a teenager thing. [A5]

Wednesdays are a good day. [A1]

Fridays so you get them before the weekend. [A8]

Weekends are more helpful. [A2]

Have more texts in the holidays. [A6]

Don’t text me during school holidays because I will not get them. I go into hibernation. [A12]

7.3.3.4 Adolescents wanted to be reminded to think about their reasons for wanting to change

The messages that included triggers for adolescents to think about their long-term goals, reasons for wanting to make changes, and their decision to participate in CAFAP were generally appreciated. The supportive nature of these texts seemed to be better received than text messages related to behaviour change.

I mean cuz, it’s like where do you want to be from here, now? What are you going to do to get to that spot? And it just kind of motivates you to say “Oh that’s my dream and I’m getting there.” [A10]

Maybe like “Why did you choose to do this program? Remember those and keep going.” I like that. [A11]

It reminds you that you’ve gotta do that because you’ve done the program but now you’ve got to do it yourself. [A12]

7.3.3.5 Practical tips were valuable inclusions in text messages

A strong theme that emerged was the preference of adolescents to receive practical and relevant examples of behaviour change. This approach of providing positive ideas for adolescents to choose to engage in seemed to be better received than the
reflective questioning style used in the intervention or negative framed messages (what not to do) that were tested in the focus groups but not used in the intervention.

*Having a healthy tip that you can actually do is good.* [A1]

*The being happier and thinking better...sometimes I need an example. Like what am I going to do?* [A2]

**Text messages were not effective motivators for change for adolescents**

Adolescents reported that although the text messages often acted as a reminder or an awareness raiser, they were not able to motivate behaviour change. Adolescents were quick to come up with reasons for why the text message wasn’t applicable to them or why they wouldn’t be able to use the healthy tips. Adolescents appeared not to be interested in thinking too deeply about the text messages or having to adapt the content to suit their lives. Parents highlighted that adolescent lack of motivation was a common barrier and thought the text messages were not successful in encouraging behaviour change.

*That’s a good message because it tells you what you should do and should not do, but you’re still going to be inactive and you’re still going to eat junk food.* [A4]

*Not really good. What’s wrong with it is (1) I don’t have an egg timer, (2) I don’t really plan on buying one, and (3) I don’t think that anyone would stay on the computer for [just] 30 minutes, I think they’d want to be on there for longer.* [A5]

*She does talk about things like going to Zumba classes with a friend but it’s all talk, nothing’s been done.* [P3]

*Don’t think it made any difference. But then it’s hard to tell what’s going on in there sometimes.* [P12]

*She’s made all of these wonderful decisions; she’s at that point where she’s gotta keep motivated to stay there. And that’s where she’s having a little bit of trouble.* [P9]
Lack of time and tiredness were barriers for adolescents to participate in healthy behaviours

Adolescents repeatedly emphasised their lack of free time to plan for or perform healthy behaviours. They identified many cases where they disregarded text messages because they didn’t feel there was enough time to implement any of the strategies offered. Adolescents also reported being too tired to participate in healthy behaviours and this was supported by parent opinions.

I don’t have time; I don’t even eat breakfast in the morning. We just don’t have that much time. [A10]

Homework. I didn’t have time to think about it [the text messages] at all. I’ve got like five projects at the moment. [A9]

I answer it [the text] in my head but the thing is I’m already tired. So by the time you’re on your weekend, you just crash. [A2]

But the exercise is not there. I think part of it is their school is really full on. They’re too tired. [P11]

Adolescents stated some texts induced feelings of shame

Adolescents reported a sense of guilt or shame associated with messages that reminded them about healthy behaviours that they were not implementing. Parents also reiterated this sense of shame emerging for their adolescent, stemming from a number of texts.

Thanks for making me feel like crap. Cuz I’m not the healthiest and I’m not the fittest and I feel really tired. And maybe I’m not as happy as I could be. [That] would just make me feel bad. [A3]

(in response to the text: Do you remember that the benefits of being more active include having a healthier heart and body chemistry, feeling less tired, sleeping better, being happier and thinking better?)

That just makes me feel really depressed if I’ve eaten a lot of junk that day. [A12]
It’s good to have healthy reminder but I notice that my daughter does respond with a level of guilt or shame. It’s a reminder in a way that she’s not doing, she could be doing more. [P1]

**Hearing about what other teenagers are doing was not motivating for adolescents**

Similarly, the majority of teens described their dislike for messages that included ideas or experiences from other teens, reiterating this sense of shame that others were improving their health whilst they were not.

*I think “Oh, other teens are better than me? Like OK maybe I should catch up a bit because next time I see them they’ll all be skinny and I’ll be like... still...still here.”* [A2]

*I think what my daughter rolled her eyes at the most was “the other teens” and she felt like she’s being compared again...she would just sort of turn off.* [P4]

A minority reported that they enjoyed hearing about how other teens were experiencing similar challenges; however, this was disparate to the perceptions of their parents’ reports, as well as the facilitators’ knowledge of the adolescents’ progress.

### 7.4 Discussion

#### 7.4.1 Main findings

The present study contributes to the evidence base around experiences of overweight and obese adolescents and their parents in response to text messages designed to support behaviour change in the maintenance period of a larger intervention. Adolescents described a sense of shame in response to the text message intervention, which was also observed by their parents, presenting a new issue for health researchers using text messaging with overweight and obese adolescents. In this study, overweight and obese adolescents’ stated preferences for text messages differed from how they actually responded to such text messages. This suggests that pre-intervention testing of messages may not adequately simulate what happens in “real life”. There may be differences between messages
that adolescents say they like and those that are actually helpful in supporting behaviour change. The consensus from adolescents was that the text messages were occasionally useful but sent too frequently and did not substantially help them to change their behaviours. Parents agreed that the text messages were too frequent and possibly too impersonal. They acknowledged there were some positive responses to the messages but the majority of the adolescents did not like to be reminded about healthy behaviours. These findings emphasise the uniqueness of overweight and obese adolescents and suggest a need to strengthen future intervention aims and evaluation methods.

7.4.1.1 Shame
Overweight and obese adolescents experience a sense of shame regarding their health and/or body (Morinder et al., 2011, Sjoberg et al., 2005). The results of this study show that regular health-related text messages have the potential to heighten this sense of shame, which is a new issue for consideration by researchers using text messaging with overweight and obese adolescents. Based on the theoretical underpinnings of CAFAP (Fenner et al., 2013), text messages were specifically worded to promote autonomy and support adolescent choices, yet many adolescents perceived the text messages as reminders of what they should be doing but weren’t doing. This response from overweight and obese adolescents differs to that described in similar studies, albeit shorter term, in adolescents of differing weight statuses (Hingle et al., 2013) or diabetic adolescents (Franklin et al., 2006) who reported to enjoy receiving health-related text messages. Similarly, suggestions about what other teens had found useful were not well-received as they had been in the pilot phase of a previous study (Woolford et al., 2011a), rather, these adolescents reported they disliked being compared to others. This response is potentially a significant barrier for overweight and obese adolescents to maintain healthy behaviours, with feelings of shame being related to poor mental health (Sjoberg et al., 2005) and in turn to poorer self-efficacy and reduced ability to engage in lifestyle changes (Melnyk et al., 2006). These feelings or circumstances may be unique to overweight and obese adolescents and suggest that results from trials involving non-obese adolescents may not be easily generalised to this group.
7.4.1.2 Want versus response

The results from this study suggest a notable difference between what overweight and obese adolescents say they prefer in a text message as opposed to what is actually useful to them in the maintenance phase following intervention. Adolescents reported that texts relating to their long-term goals were useful to motivate them, yet they had difficulty with maintaining behaviour change and parents reported significant issues with adolescent motivation. Adolescents were able to point out flaws in the text message content and suggest improvements; however, many of these included strategies previously used or previously criticised by the adolescents themselves. Similarly, adolescents expressed a desire for practical tips to use in their daily lives reflecting current evidence (Hingle et al., 2013, Woolford et al., 2011a), yet were quick to highlight reasons that would prevent them from regularly using the tips. They identified a number of barriers including lack of time or lack of resources (e.g., particular foods not available), but weren’t able to suggest many ideas to overcome these. Interpretation of these results suggest that adolescents are able to identify idealistic concepts for text message style and content that may make theoretical sense, but have difficulty envisioning their actual response to such messages. This has potential implications for researchers doing pre-intervention testing with overweight and obese adolescents because the views they express may indicate that the intervention will be useful but might not be a true reflection of their experience in a text message intervention. Currently, the majority of the evidence around text message development for overweight and obese adolescents is based on the assumption that adolescents know what will be helpful to them in a text message and can articulate that; however, these results suggest that this may not be the case. Qualitative post-intervention research may provide the most contextual data regarding overweight and obese adolescents’ reaction to text messages, but even within these results there are inconsistencies between what adolescents say they want and what they actually respond well to.
7.4.1.3 Purpose of text

Text messages are often used with adolescents to (1) encourage behaviour change or maintenance, and (2) to foster engagement between adolescents and interventions; however, this research suggests that it may be difficult to concurrently achieve both of these aims in a weight-related intervention using text messages. The overweight and obese adolescents in this study did not like receiving text messages reminding them to maintain healthy behaviours, and thus such messages have the potential to damage the therapeutic relationship established during a face-to-face intervention and hence ongoing engagement.

In this study, overweight and obese adolescents’ responses to the text messages became increasingly negative over time. This suggests that their motivation may decline over time leading to failure to maintain behaviour changes. Many parents in this study reiterated that adolescents didn’t like to be prompted about healthy things they could be doing, although they felt that it was sometimes useful to encourage behaviour change. Despite adolescents reporting their dislike of the text messages, the healthy behaviour focus may have had a positive effect on adolescents’ health. The effectiveness of using texts as healthy behaviour prompts is not clear, with some evidence suggesting that this may be effective in promoting behaviour change in the long-term (Fry and Neff, 2009, Fjeldsoe et al., 2011), while other evidence suggests that eliciting a negative or shameful response to a message results in a reduction in self-efficacy and lack of behaviour change (Melnyk et al., 2006). This delicate balance between prompting behaviour change and avoiding a shameful response may account for some of the differences reported in the literature relating to effectiveness of text messaging interventions in overweight and obese adolescents (Woolford et al., 2010, Woolford et al., 2011a).

Conversely, messages not related to weight or healthy behaviours may be more effective at keeping adolescents engaged with an intervention. In this study, adolescents expressed a desire for more casual and positive text messages, which may have been more suited to preserving links with the intervention rather than eliciting behaviour change. If the intervention aim was to preserve links with adolescents, then text messages would need to be carefully constructed to foster
this sense of engagement but could be completely unrelated to the behavioural aims of the intervention. Message development based on self-determination theory would therefore aim to promote a sense of connection for the adolescent (Deci and Ryan, 2000). To our knowledge, the use of text messaging interventions to foster engagement has not been tested independent of behaviour change and should be explored in future research.

The current findings suggest that future studies would benefit from generating clear aims for text messaging interventions specifically relating to either behaviour change or engagement, and designing the texts with these aims in mind. Similarly, evaluation methods need to be strengthened and appropriate measures used to assess whether the text messages actually achieve their intended aims.

7.4.1.4 Timing

Adolescents expressed a number of differing opinions regarding the timing of the texts messages, suggesting that it may be most acceptable if timing is personalised to each participant’s preferences. In the current intervention, messages were sent three times per week. Adolescents and parents consistently reported that the frequency of the text messages was excessive and they found that the messages became boring over time. This is in contrast to other studies with even greater frequencies of contact (Woolford et al., 2010, Shapiro et al., 2008, Hingle et al., 2013, Sirriyeh et al., 2010, Franklin et al., 2006) where adolescents were reported to be accepting of daily texts, although 20% of participants in one study indicated that they got bored of receiving the same or similar text messages (Franklin et al., 2006). Interestingly, only one of these studies (Woolford et al., 2010) was directed at overweight and obese adolescents, suggesting that this group may have unique perceptions regarding the frequency of supportive text messages and this may be related to how well they are achieving their lifestyle goals. Nguyen et al. (2013) sent a text message once per month on average to overweight and obese adolescents but suggested that this dose was possibly too low to have an impact. The desire for less frequent text messages in this study may be related to the sense of guilt overweight and obese adolescents describe when they are reminded about changes they aren’t making, although it remains unclear as to whether this can prompt
behaviour change. These results highlight how messages can possibly invoke an undesirable response in overweight and obese adolescents. Text messages become personal because they are sent to the participant’s phone and differ from other health messages on media such as television where the individual may be able to more easily ignore a message as they are perceived as not relevant to them. When an individual receives and reads the text message, they will make a decision as to how relevant or useful the information is for them. From the responses obtained, it appears that, in overweight and obese adolescents, health messages may invoke a response that reduces their motivation to change rather than stimulating them to continue to take action to increase their physical activity or improve their diet. Health researchers may therefore need to modify the logistics of text message delivery to best suit the aims of their intervention, be that engagement or behaviour change.

7.4.1.5 Style

Focus group participants were unanimous in their call for more casually worded text messages. Adolescents have previously expressed a preference for health care providers to communicate via text using a natural tone while avoiding the use of text message “slang” as frequently used in adolescent-to-adolescent contact (Woolford et al., 2011a). Despite attempts to use less formal language than in the previous study, our research suggests that the tone we used was perceived as too professional by adolescents. The addition of symbols and emoticons (e.g., exclamation marks and smiley faces) to text messages may help to convey a less formal tone. Although most text messaging studies have used tailored messages (Woolford et al., 2010, Shapiro et al., 2008, de Niet et al., 2012b, Kornman et al., 2010, Franklin et al., 2006, Woolford et al., 2011a, Fjeldsoe et al., 2009, Mauriello et al., 2010), our research suggests that overweight and obese adolescents want them to be further customised to their individual goals and experiences. Adolescents also reported that negatively worded texts (e.g., “don’t eat junk food”) were likely to increase the likelihood of actually performing those behaviours, supporting recent findings by Woolford et al. (2011a). These authors suggested that overweight and obese adolescents often want to avoid the psychological work associated with
reflection and instead prefer tips and testimonials from other adolescents (Woolford et al., 2011a), yet our results suggest that overweight and obese adolescents in actuality do not find these helpful to assist with behaviour change.

### 7.4.1.6 Parents

No other studies to our knowledge have included parent perceptions of their overweight and obese adolescent’s responses to receiving supportive text messages. Including parent views help to understand the differences in opinions that adolescents might express to parents when at home, as opposed to researchers. This triangulation of the data provides a richer sense of what the “real” truth may be. The views expressed by parents in this study were generally aligned with the opinions described by adolescents and were also useful in identifying inconsistencies described by individual adolescents whose views consistently differed from the overall group.

### 7.4.2 Limitations

As with all qualitative studies, there are potential limitations associated with participants reporting a view that may be perceived as socially acceptable, rather than their true opinion. It is possible that overweight and obese adolescents in particular may be prone to report in this way. The focus group facilitators in this study were known to the participants, which may have influenced participants to offer a more positive view on the use of text messages; however, the sometimes negative opinions expressed by parents and adolescents suggest this was not the case. The small size of the focus groups may have either encouraged or impeded discussion. It is also not possible to determine directly how the messages affected their behaviour and if they took action. For example, some irritation with the messages may still have served as a reminder to increase their physical activity or improve their diet. The strengths of this study include an appropriate qualitative design to address the research question, a range of informants with directly relevant opinions for the research question, the inclusion of parents and adolescents, and provision of novel, in-depth information about the challenging topic of providing support to overweight and obese adolescents following an intensive intervention period.
7.4.3 Implications for research and practice
This study presents several implications to consider in future research. First, overweight and obese adolescents may not know or have the ability to articulate how they would best be supported during the maintenance phase. Second, researchers should generate clear aims when planning a text message intervention, and develop appropriate methods of measuring success relative to the specific aims (for example engagement or behaviour change). Third, timing and content of messages may need to be more individualised and may require ongoing input from adolescents to understand their preferences for receiving text messages. Fourth, reports of parent experiences may offer a useful secondary view of adolescent responses to text message interventions. Last, overweight and obese adolescents might be more susceptible to feelings of guilt or shame than non-obese adolescents when reminded about maintaining behaviour change.

7.5 Conclusion
Findings from this study suggest that text messages may have a useful role in interventions for overweight and obese adolescents but that adolescent opinions pre-intervention may not be very predictive of their actual experience and that it may be difficult to achieve both enhanced engagement and behaviour change simultaneously. The results emphasise the importance of message tone, content, and timing as these factors appear to impact on how the messages will be received by overweight and obese adolescents. The potential to initiate feelings of shame in adolescent recipients of text messaging was identified as an important issue. The study also supported the use of process evaluation to help inform further interventions, and highlights the value of parent and adolescent reports. Future research should be clear on the engagement or efficacy aims for an intervention, develop messages to accommodate adolescent preferences in conjunction with an appropriate theory, and employ appropriate evaluation measures of engagement or effectiveness.
Chapter 8.0 Discussion

8.1 Introduction
This thesis described the diet and attitudes of overweight and obese adolescents before, during and after participating in Curtin University’s Activity, Food and Attitudes Program. A pictorial summary of how the studies fit into the overall research project is included in Appendix S.

The studies reported in this thesis aimed to address major gaps identified in prior evidence and in doing so have contributed substantially to the evidence base for dietary interventions for obese adolescents.

The objectives of this thesis were:

1) To investigate the perceptions of adolescents, parents and stakeholders regarding barriers and facilitators to recruitment, retention and maintenance associated with a healthy lifestyle program

2) To examine the patterns of dietary intake for obese adolescents entering a healthy lifestyle program

3) To provide a detailed description of the development of the dietary component of CAFAP

4) To assess adolescent dietary change for food groups, energy intake, nutrients, eating behaviours and adherence from post-intervention to 12 months post-intervention

5) To evaluate the experiences of adolescents receiving text messaging support during the maintenance period

This chapter provides a discussion of each of the objectives and associated findings from this thesis, in the context of prior research, to show how the identified gaps in the literature have been addressed. This is followed by a discussion of the strengths and limitations of each of the thesis studies, and how the findings can be used in
future research and practice. The chapter concludes with a discussion of the three overarching themes that arose from the studies in this thesis:

1) Challenges in obtaining a robust assessment of obese adolescent diet

2) Challenges in developing and implementing a dietary intervention for obese adolescents

3) Challenges in supporting maintenance of healthy behaviours in obese adolescents

8.2 Barriers and facilitators to recruitment, engagement and maintenance

Gap: Lack of strong evidence to guide effective intervention delivery for overweight and obese adolescents

Objective: To investigate the perceptions of adolescents, parents and stakeholders regarding barriers and facilitators to recruitment, retention and maintenance associated with a healthy lifestyle program

Study A identified several barriers and enablers that have the ability to impact on the success of interventions for overweight and obese adolescents. The findings from this qualitative study of adolescents, parents and stakeholders showed that these barriers and enablers can occur at the recruitment stage, intervention stage and during the maintenance phase. A number of factors were perceived as both barriers and enablers by participants, depending on whether they were present or absent. For example, a location that was difficult to get to might be a barrier for a parent, whereas a location on the way home from school (even if difficult for parents to get to) might be an enabler for an adolescent. Study A concluded that pre-program planning to consider community-specific barriers and enablers is critical to the success of future healthy lifestyle interventions.

The following section includes a summary of the key findings and discussion of how the findings from Study A advance the existing evidence base for each of the key areas of recruitment, retention and maintenance. This is followed by a
consideration of the strengths and limitations of this study and a summary of the study implications for future research and practice.

8.2.1 Recruitment
Study A showed that significant barriers exist for adolescents and parents to overcome to actively engage with a healthy lifestyle program. The identified barriers to recruitment included adolescent embarrassment about being overweight or needing help and normalised levels of overweight that make it difficult for parents to identify their child as overweight. These barriers were further highlighted by a lack of expertise in health professionals to identify overweight in adolescents, a lack of current services for overweight adolescents, and broader social barriers. There were also a number of strategies identified to enable adolescents and parents to sign up for healthy lifestyle programs, which should be considered by researchers and health professionals. The enablers for recruitment included extensive advertising, using a positive tone and message and making the program free to families.

Previous studies have reported conflicting results about how to best recruit overweight and obese adolescents (Nguyen et al., 2012a, Rice et al., 2008). The findings from Study A in this thesis add to this evidence base by emphasising the importance of working with local communities to understand how to best interact with existing services and developing community-specific approaches to recruitment. Based on the views expressed by adolescents, parents and stakeholders in Study A, CAFAP was promoted using advertisements via health professionals, community newspapers and radio, along with the distribution of flyers to local neighbourhoods. Even following this work with local communities, recruitment for CAFAP took three months longer than anticipated.

Study A highlighted the need for adequate recruitment time and targeted recruitment strategies in future research. Further, it was evident from comments by stakeholders that during the recruitment period, investment of sufficient staff time is critical to engage local communities and provide repeated, positive exposure for the program. Without this high visibility in the community, participants may not feel
comfortable about enquiring or registering with the program, nor will health professionals know to refer eligible families. Further, a lack of existing services in the community means that there may not be a group of overweight adolescents and their parents who have already been identified as candidates for such a service and are ready to engage. Thus, a large amount of work may need to be done to raise awareness in the community. This raises an ethical issue to consider in future research, around the difficulties associated with building demand for a service that may only be relatively short-lived. This may also not be a cost-effective approach for services that will not be ongoing. For example, a research program for overweight adolescents is going to be dependent on project funding, and will likely have an already specified end date. This has been the experience following the delivery of CAFAP in the community, with enquiries from health professionals and parents continuing for 18 months following the conclusion of the intervention delivery as part of the research project. There was no funding available to continue to offer CAFAP as a health service following the research evaluation project. This highlights the need for a long-term funding commitment to health services for overweight and obese adolescents, which would allow for a period of establishment of services and an opportunity to deliver services to meet ongoing needs. Further, in research programs, community links should be identified to refer enquiring participants to once research project funding has ceased. Longer funding periods will also allow for sufficient data collection to prove the effectiveness of programs in the long-term. However, if there is insufficient demand for such an intervention after an extended period, then this investment would not be considered cost effective. Future research will need adequate recruitment time to be built into the study timeline, a number of far-reaching and positive recruitment strategies and strong links with existing community organisations in which to promote the program.

8.2.2 Retention
In Study A adolescents, parent and stakeholders identified barriers to retention during the intervention including an inability to access the location of the service, timing and work conflicts, other family commitments, and broader social barriers. The enablers for retention during the intervention included making the program
fun, developing practical skills, including the whole family, incorporating online components, employing good staff, encouraging goal setting and making attendance easy and rewarding for parents. A number of these factors can also be classified as barriers or enablers depending on the context.

The main difficulties identified in Study A by adolescents and parents who completed the pilot CAFAP intervention were similar to those previously described by Brennan et al. (2012) and Skelton et al. (2012), including travel difficulties, lack of interest and lack of time. The results from Study A in this thesis add to the evidence by identifying barriers specific to the local community where the future CAFAP intervention was to be delivered. Thus, the design of the intervention was able to address the barriers of location, timing and other social issues that are experienced by adolescents and parents in Western Australia. Further, the identification of enablers, or strategies to overcome these barriers, contributes a positive and novel way of highlighting the key components of intervention design as perceived by adolescents, parents and stakeholders. These barriers and enablers were incorporated into the design of the CAFAP intervention and the program development has been published elsewhere (Straker et al., 2012).

Study A highlighted the logistical difficulties associated with delivering an intervention to families. There is a clear mismatch between times that suit adolescents (after school) and times that suit parents (after work) and that do not also clash with family mealtimes or evening routines. Further, the location of the intervention is critical to make participation as easy as possible for families. Research projects and health programs should consider consulting future potential participants prior to intervention, to determine the most appropriate time and venue for their target group.

The findings from Study A also emphasise the importance of how the program is experienced by the participants. Adolescents need to perceive the program as fun and parents need to know their adolescent is having a positive experience. This is particularly important for healthy lifestyle interventions as previous research has suggested that overweight adolescents experience feelings of shame and guilt.
associated with accepting treatment (Morinder et al., 2011, Sjoberg et al., 2005). As much as diet and physical activity are critical components of treatment, there may be difficulties with retaining participants if having fun is not a key outcome for healthy lifestyle programs. Future program delivery should include fun and practical activities, with opportunities for participants to give feedback about how they are enjoying the program. Fun activities may help adolescents to identify enjoyable hobbies that they may be interested in pursuing following the intervention, thus having the potential to support long-term behaviour change.

8.2.3 Maintenance

Finally, Study A identified a number of barriers to maintenance including the inherent difficulties with sustaining changes and a lack of existing services to support change. The enablers for maintenance included providing adequate follow up, improvements that are noticeable to adolescents, offering online support and transitioning adolescents to existing community services. The maintenance component of CAFAP is discussed in detail later in this chapter (see section 8.6 and 8.7.3).

No prior studies were identified that have investigated the perceptions of participants or stakeholders regarding the barriers and enablers to the maintenance of weight loss and behaviour change in overweight adolescents. In Study A, stakeholders highlighted a general lack of knowledge about how to best support adolescents to maintain weight loss and behaviour change. It seems that the maintenance period has not been well evaluated in children or adolescents (Pratt et al., 2008). This may be because the evidence is still evolving for how to most effectively deliver active interventions, prior to the maintenance period. Thus, the findings from this study fill a significant gap in the literature by describing issues for researchers and health professionals to consider following delivery of healthy lifestyle interventions. The views described in Study A were incorporated into the design of the maintenance period for CAFAP, as described in Study E. Regular and positive contact was offered following the intensive intervention, along with online support to keep adolescents involved with the program. This was not particularly well received, so future detailed evaluation of maintenance contact will be
important for future interventions (discussed further below). During the intensive intervention, there were several opportunities for participants to identify new activities that they enjoyed, or existing activities in the community that they may be interested in pursuing. The post-intervention evaluation of the maintenance program described in Study E will be useful to help other interventionists to understand more about what helped adolescents to continue with healthy behaviours.

In a review of diet and physical interventions for overweight adolescents, Ho et al. (2013) concluded that participants were likely to regain some of the weight lost during the active intervention, and the effect of metabolic improvements would be lost. Indeed, during the CAFAP maintenance phase, many of the positive behavioural changes regressed towards baseline values. Thus, it is critical that future intervention designs incorporate ways to address the barriers that may prevent adolescents from keeping up with behaviour change. Existing community structures, such as youth centres or sporting groups, may be identified during the recruitment phase if program designers work with local communities to guide their intervention. These services may be useful to support adolescents maintain behaviour changes following an intervention. There is also a clear need for researchers to evaluate the effectiveness of maintenance programs offered to overweight adolescents, to identify successful strategies to support them in long-term change.

8.2.4 Strengths and limitations
Strengths of Study A include the sound theoretical framework used to design the interview and focus group schedules, and the in-depth information garnered from a varied group of informants. This allowed for integration of themes that potential participants perceived to be a barrier, as well as those that previous participants had actually experienced. The large sample of researchers, allied health professionals and community representatives also provided a comprehensive professional summation of potential barriers and enablers to participation. The overall limitations of Study A included difficulties recruiting overweight adolescents to participate in the focus groups, resulting in a relatively homogenous and smaller
than desired sample of five past-participants and 39 potential participants. However, the numbers were sufficient to achieve saturation and reflected the target group for the planned future intervention. This does limit the applicability to other community groups, but highlights the need for future research to include sufficient consultation with the local community prior to intervention.

8.2.5 Implications for research and practice
Overall, Study A raises a number of issues to consider in future practice and research. Barriers to effective service delivery exist at the levels of recruitment, retention and maintenance. Such barriers may be specific to the local area, and investigation of these is important to maximise the results of a healthy lifestyle program. Study A also showed that adolescents, parents and stakeholders can identify their own ways of overcoming these barriers. Thus, there is a critical need to engage local communities in the planning of service delivery. This includes communicating with potential participants, stakeholders who have previously worked with the target group and existing agencies that are well-placed to provide additional support to participants. Such engagement will provide exposure to assist with recruitment, guide intervention design to maximise retention and identify existing services to support maintenance of healthy change following intervention.

8.3 Dietary intake of obese adolescents
Gap: Lack of detailed evidence to describe what overweight adolescents eat and drink

Objective: To examine the patterns of dietary intake for obese adolescents entering a healthy lifestyle program

Study B in this thesis described the diet of overweight adolescents entering a healthy lifestyle program, using a food group-based approach. This included analysis of how intakes of key food groups differed by time of the day and day of the week. Prior to participating in the CAFAP intervention, the diet of the 61 overweight adolescents enrolled in CAFAP was characterised by high intakes of junk food (5.8 servings) and low intakes of fruit (0.7 servings) and vegetables (1.2 servings). The patterns of intake of these key food groups showed that both overweight girls and
boys were more likely to eat fruit on weekdays than weekends (girls OR=5.0, boys OR=2.5) and ate more fruit at school than at other meals (girls: IRR=7.5, boys: IRR=4.0). Overweight girls were most likely to eat vegetables at dinner on a weekday (OR=3.0) and eat fast food at dinner on a weekend (OR=9.6). They also ate more ‘other junk’ food at school than at other meals (IRR=7.2). Overweight boys ate the most vegetables at dinner on a weekday (IRR=30.9) and ate more fast food on the weekend than on weekdays (IRR=3.6). Boys also drank more sugar-sweetened beverages on the weekend (IRR=3.3). The results suggest that the intake of fruit, vegetables and junk food by overweight adolescents is poor and that there are distinct patterns consumption over time and day that differ for boys and girls. This understanding is useful in the development of targeted dietary messages relevant to overweight adolescents that may guide the improvement of dietary interventions for adolescents.

The following section includes a comparison of these findings to prior research and discussion of how the findings from Study B advance the existing evidence base regarding overweight adolescent intake of fruit and vegetables, and then junk food. This is followed by a summary of the strengths and limitations of this study, and implications for future research and practice.

8.3.1 Fruit and vegetable consumption

Previous research into overweight adolescent fruit and vegetable consumption habits is limited. The data comes from large cross-sectional studies or smaller intervention studies describing diet at baseline. For fruit, previous figures suggest 41% of overweight and obese Australian adolescents report consuming at least three pieces of fruit per day (Morley et al., 2012), while 71% overweight adolescents starting an Australian intervention reported consuming at least two pieces of fruit per day (Shrewsbury et al., 2011a). These two studies use different reference points for adequate intake of fruit (two versus three servings), but the proportion of overweight adolescents meeting recommendations appear much higher than the 7% of CAFAP participants identified as consuming three or more servings of fruit. For vegetables, 24% of overweight adolescents reported consuming four or more servings in the cross-sectional study (Morley et al., 2012)
and 26% of overweight adolescents reported consuming the same amount in the intervention study (Shrewsbury et al., 2011a). In Study B, none of the participants reported consuming four or more servings of vegetables prior to intervention.

The marked difference in proportion of adolescents meeting the guidelines for fruit and vegetable intake may reflect the different methods of dietary assessment used. The first two studies used FFQs (Morley et al., 2012, Shrewsbury et al., 2011a), which do have potential to overestimate intake, particularly for vegetables (Calvert et al., 1997). Study B in this thesis used three day food records to measure fruit and vegetable intake, which is a more robust dietary assessment method that is less affected by systematic error than FFQs. The strengths of the method of dietary assessment used in this study are discussed further in section 8.3.4. Therefore, the results from Study B add to the evidence base by using robust dietary assessment methods to more accurately reflect the intake of fruit and vegetables by overweight adolescents than previous studies.

In terms of estimating combined intake of fruits and vegetables, only three adolescent overweight intervention studies investigated consumption levels at baseline, with two studies reporting 2.9 combined servings (Shaibi et al., 2012, Wengle et al., 2011) and one study reporting 2.4 combined servings (Bean et al., 2011). The findings from Study B suggested overweight adolescents consumed 0.7 servings of fruit and 1.2 servings of vegetables prior to participation in CAFAP, adding to the small existing knowledge base. The differentiation between fruit and vegetables is useful to identify opportunities for improvement. For example, if the previous 2.9 servings all came from mashed potato, then this diet might provide more fat than if the 2.9 servings were all fruit-based. Further, the goals that the adolescent might set around healthy eating would be quite different if they were already consuming the recommended amount of fruit, but not consuming any vegetables. The separation of fruit and vegetable intake is also useful in testing the effectiveness of the intervention at changing specific food group intake. The findings from Study B also provide a high level of detail regarding the amount of fruit and vegetables consumed and likelihood of consumption at each time point, which extends the existing evidence considerably. There is potential for this
information to be used to guide the development of dietary interventions, or to assist adolescents in becoming more aware of periods that may include particularly low levels of fruit and vegetable consumption. This information has the potential to be used to enhance guided goal setting and help adolescents to monitor their own consumption patterns. Some potential targeted messages have been proposed in Chapter Four, which could help adolescents to choose highly relevant goals yet still maintain their sense of autonomy (Shilts et al., 2004b).

8.3.2 Junk food consumption
Previous estimates of overweight adolescent intake of junk food have not been well-described in the literature. Overweight adolescent intake of junk foods is also difficult to compare between studies due to a lack of standardised measures and definitions. Shaibi et al. (2012) measured dietary intake in a group of 15 Latino adolescents using a brief screening tool, which defined servings of ‘fat’ as foods that contribute to the top 60% of fat intake such as fried chicken, whole milk, French fries and cake (Wakimoto et al., 2006). This study reported 3.3 servings of ‘fat’ per day in this group of adolescents, however this data is susceptible to the influence of extreme outliers, as only there were only 15 subjects in the study. Wengle et al. (2011) reported 4.2 servings of high fat/sugar foods per week but the study lacked a clear definition for how these servings were calculated, or why they were assessed over a week. The findings from Study B expand the knowledge regarding junk food intake of overweight adolescents by classifying junk food intake using previously published criteria (Rangan et al., 2008), which also allows for replication of the findings. The estimation of 5.8 servings of junk food for CAFAP participants appears much higher than previous reports. The number of participants in Study B (n=61) is considerably greater than that of Shaibi et al. (2012) (n=15) and Wengle et al. (2011) (n=38). A larger sample size is important as it reduces the impact of random error and thus, increases the precision of findings (Rutishauser, 2005).

8.3.3 Temporal patterns of consumption
There are also very few previous attempts to describe the consumption patterns of overweight adolescents by time of day and day of week, which is important in the development of targeted messages relevant to adolescents. A recently released
Australian report describes a typical temporal pattern for female and male adolescent dietary intake but lacks detail for overweight adolescents (Commonwealth Scientific and Industrial Research Organisation, 2012). This previous report shows some similar trends, with vegetable intakes highest at dinner for both boys and girls and minimal intakes of fruit at breakfast time. However, in this report, it is difficult to quantify the overall intake of junk foods because the analysis was based on food groups as determined by a software program rather than the dietary guidelines. The food groups were categorised based on the main ingredient, for example ‘cereal-based products and dishes’, which does not correlate with the core food groups in the Australian Guide to Healthy Eating. Therefore, if using the main ingredient method of classification, meat pies would classified as ‘cereal based products and dishes’, as would wholemeal bread. However, using the Australian Guide to Healthy Eating, meat pies would be classified as a discretionary food (junk food) and wholemeal bread would be classified as breads and cereals (core food). Thus, based on the main ingredient, the servings of this food group would not equate to the servings of junk foods. Therefore, it is impossible to quantify the number of servings of junk foods in total or by time of day using the data from the previous report, nor is it possible to compare the junk food intake reported to the findings from Study B in this thesis. The data from Study B also extends the evidence base by describing weekday versus weekend trends, which has not been considered in overweight adolescents to date. The findings relating to significantly different patterns of intake depending on the day of the week has important future implications for intervention design.

8.3.4 Strengths and limitations
A major strength of Study B was the number of strategies used to maximise the quality of the dietary data collected. Firstly, a standardised protocol was developed for data collection to ensure consistency in the way instructions were given and data was collected. Briefly, two methods of dietary assessment were selected to collect detailed dietary information. A three day food record was used to capture detailed information about time of eating and portion sizes, along with a brief questionnaire to collect information about key eating behaviours and self-perceived
dietary intake. Based on current recommendations in the literature, a dietitian was involved in data collection (Burrows et al., 2012) and participants were encouraged to use brand names in their reporting (Thompson and Subar, 2013). Although the evidence to support the use of portion size training is very limited (Livingstone et al., 2004), participants were taught how to measure portion sizes using a set of provided household measures. The dietitian reviewed the food records with adolescents to clarify details on the types and amounts of food and beverages reported and to probe for forgotten foods. Secondly, the use of Foodworks software based on the AUSNUT and NUTTAB databases was clearly described in all publications for this thesis. Thirdly, diet was comprehensively reported in terms of energy intake, food groups, and nutrient intake by time and day to provide a detailed description of diet. Additionally, macronutrients were presented as a percentage of total energy, which is thought to be less affected by underreporting than if presented in grams (Hirvonen et al., 1997). Based on previous experience of the difficulty of collecting detailed dietary reports (Straker et al., 2010), adolescents were also offered small monetary incentives based on the thoroughness of the reporting in their record. A thorough report was considered to be one that used of brand names where possible and clearly described portion size. These incentives considerably improved the quality of the dietary records from the pilot study.

Limitations of Study B include the potential for underreporting of intake, which is common in overweight adolescents (Singh et al., 2009). This limitation applies to all studies that require subjects to report their own intake, and is difficult to overcome. However, as described above, these results represent robust dietary assessment methods. Further, the estimation of adherence assumes that three day food records accurately capture usual intake. This is a limitation associated with food records (Thompson and Subar, 2013), and to overcome this adolescents were asked to indicate any atypical days in their food records. The small number of boys in this study, and the overall modest number of subjects reduces the generalizability of these findings, as does the homogeneity of this white, low/middle socio-economic status group.
8.3.5 Implications for research and practice
The findings from Study B can be used in future research and practice, to guide adolescent goal setting around healthy eating. At the time of CAFAP implementation, the recommendations for the use of targeted dietary messages in intervention had not yet been developed. Instead, adolescents were given feedback about their dietary intake to use with goal setting, as discussed in the following section. The information adolescents received related to their intake of fruit, vegetables and junk food from the initial food records and some examples of ways to meet their goals. This information was intended to raise awareness about their individual consumption patterns and help them to set specific and challenging goals. However, this information may not have been targeted enough. For example, many adolescents had difficulty setting goals around healthy eating altogether. Further, many adolescents rated themselves as achieving their healthy eating goals to increase vegetable intake following the intervention (Fenner, 2014), despite no change in vegetable consumption from the food records. Thus, future interventions could trial the use of targeted dietary messages to raise adolescent awareness about the day and time of fruit, vegetable and junk consumption and evaluate the effectiveness of these more specific messages. It would be useful to understand how adolescents might use these messages, and whether facilitators would find it beneficial to have examples of common adolescent habits to guide their communication with adolescents around goal setting.

8.4 Detailed description of dietary intervention
Gap: Lack of detailed descriptions of dietary components of multicomponent interventions, and lack of evidence for the implementation of these

Objective: To provide a detailed description of the development of the dietary component of CAFAP

Study C included a detailed description of the dietary component of CAFAP, with explanations of the application of a theoretical foundation, the development of the dietary component and previous use with overweight adolescents, the session topics and supporting literature, and finally how diet-related goal setting was
tailored to each adolescent. Section 8.4 compares this to the development and 
reporting of previous dietary interventions of multicomponent programs, followed 
by a discussion of what this information adds to the existing evidence.

8.4.1 Detailed description of the development and design of 
the CAFAP dietary intervention
There is a lack of clear recommendations in the literature to guide the development 
and reporting of dietary interventions for overweight adolescents. This may explain 
why prior to CAFAP there have only been a small number of trials that have 
provided a detailed description of the dietary component of their intervention. 
Thorough reporting of dietary interventions is important to allow for replication of 
studies to understand the effectiveness of dietary components, thus strengthening 
future intervention design (Ho et al., 2012). However, it remains unclear as to which 
details should be reported. Information previously reported in some adolescent 
obesity interventions, albeit not consistently, include the application of a theory, 
development and prior testing of the dietary intervention, session content and the 
use of diet-related goal setting. These four concepts are discussed further in 
relation to the CAFAP intervention and previous interventions for overweight 
adolescents.

8.4.2 Use of theory
The CAFAP intervention was strongly grounded in self-determination theory and 
goal setting theory (Fenner et al., 2013). All dietary sessions were based on these 
two theories and aimed to encourage adolescents’ intrinsic motivation for healthy 
eating by supporting their needs for competency, autonomy and relatedness. 
Parents were also trained to create need-supportive environments in the home 
(Fenner et al., 2013). This strong use of theory to guide intervention development 
has not been commonly reported in prior literature. Only two previous studies 
provided brief descriptions of dietary interventions and commented on how the 
dietary intervention related to the theoretical underpinnings of the larger 
intervention (Shrewsbury et al., 2009, Shaibi et al., 2012). A further two relevant 
prior studies had reported the theory used in the development of their 
intervention, but neither had described how this has been incorporated in the
design of the dietary component of the intervention (Bean et al., 2011, Lloyd-Richardson et al., 2012). Two other key studies provided no clear description of any theory use (Janicke et al., 2008a, Resnicow et al., 2005). There is strong support in the literature for overweight intervention studies to include detailed reporting of the theories employed to allow for replication and implementation of evidence-based interventions (Abraham and Michie, 2008). The description of the implementation of self-determination theory and goal setting theory in CAFAP is likely to be useful to aid understanding of the mechanisms for program effects.

8.4.3 Development of dietary components
The development of dietary interventions is not well reported in the literature. Although general clinical practice guidelines exist, there is no one well-accepted method for delivering the dietary component of an obesity intervention. Thus researchers and health professionals do not have a strong evidence base to guide dietary intervention development. In addition to a lack of guidelines for design, there have been limited reports of pilot testing of dietary interventions to assess acceptability. The dietary intervention used in the CAFAP was a food group-based approach and had been piloted with overweight and obese adolescents prior to use in the current trial. Previous outcomes had shown positive dietary changes (Straker et al., 2010) and qualitative research with participants in the pilot programs informed improvements to the full trial (McManus et al., 2012). Only three studies have described using the dietary approach in a pilot study before incorporating it into a larger trial (Savoye et al., 2007, Davis et al., 2009a, O’Connor et al., 2008). Based on a pilot program, Savoye et al. (2005) concluded that a prescribed dietary plan was less effective than a healthy eating/food group-based approach, yet this option was still included in their subsequent randomised controlled trial. However, the prescribed dietary plan arm was eventually dropped after a high attrition rate associated with the meal plan. Davis et al. (2007a) developed nutrient-based recommendations to reduce sugar intake and increase fibre intake in overweight adolescents. This approach was pre-tested in small pilot groups of Latino adolescents before being employed in the randomised controlled trial (Davis et al., 2009a). The authors found evidence to support ongoing use of this nutrient-based
approach with short-term positive changes in sugar and sugary beverage intake (Davis et al., 2007a), and associated improvements in insulin secretion (Davis et al., 2007b). The study by Shrewsbury et al. (2009) used a food-based dietary intervention that had been pre-tested with overweight adolescents. This approach had shown to be acceptable but had not been associated with dietary changes (O'Connor et al., 2008). Other trials have used dietary approaches that have been evaluated in children but not adolescents. For example, many trials have used a modified version of the Traffic Light diet, which was designed for younger children aged 6-12 years (Diaz et al., 2010, Janicke et al., 2008a, Johnston et al., 2007, Saelens et al., 2002). This is a limitation of these trials given the lack of evidence to support the use or effectiveness of this approach in adolescents. One other relevant study (Resnicow et al., 2005) did not describe where the dietary intervention had originated from, thus limiting the ability to understand change or replicate findings.

The lack of evidence-based, pre-tested dietary interventions available for overweight adolescents is a significant barrier to the delivery of optimal interventions. As a result, many studies are potentially incorporating dietary components that are not well-suited to adolescents or have not evolved from a strong evidence base. The developing and pre-testing of dietary interventions for adolescents is an onerous task, however, a description of this work is critical to improve the quality of such interventions.

8.4.4 Session content

Session topics are not consistently described in the literature, possibly due to the lack of importance placed on this material in the development of manuscripts. Regardless, the absence of reporting makes it difficult to understand how the number of dietary sessions and topics covered may differ between interventions and how this impacts on dietary outcomes. The twelve diet sessions provided in CAFAP have been described in Study C, with evidence-based rationale in Appendix L. This adds a substantial amount of new detail to the existing evidence base. Only four prior studies have listed the diet topics covered in the intervention but not provided a rationale for why these were selected (Bean et al., 2011, Shaibi et al., 2012, Savoye et al., 2007, Lloyd-Richardson et al., 2012, Jelalian et al., 2010). Two
prior studies did not describe the session topics at all (Janicke et al., 2008b, Resnicow et al., 2005) and one previous study provided the evidence for the dietary approach but did not state the session topics (Davis et al., 2007b). The reporting of the CAFAP dietary intervention furthered the existing evidence by reporting the diet session topics and providing evidence for why these topics were included. This detailed description supports better replication and understanding of the potential mechanisms of effect.

8.4.5 Use of diet-related goal setting
The use of goal setting in relation to diet is not well-described in the literature. The use of goal setting theory in the development of CAFAP has been described elsewhere (Fenner et al., 2013), and the application to goals about diet has been described in Study C. The use of feedback regarding current diet to inform goal setting is a strength of the intervention design. Most other studies have only indicated if goal setting was used at any stage in the intervention to encourage behaviour change. Only two studies described how goal setting was used to complement the dietary sessions (Bean et al., 2011, Janicke et al., 2008a), and five studies that used goal setting did not report how this was used in the dietary component of the intervention (Shaibi et al., 2012, Davis et al., 2009a, Savoye et al., 2007, Resnicow et al., 2005, Jelalian et al., 2010). In contrast, the detailed description of the use of goal setting in the dietary component of CAFAP provides a new approach to goal setting and allows for replication in future studies.

8.4.6 Implications for research and practice
In Study C, the detailed description of the dietary component of CAFAP provides considerably more information about the delivery of the dietary intervention than any of the existing reports of other multicomponent interventions. There are no other studies that provide details about all of the components of dietary intervention including the application of theory, prior testing of the intervention, session content and use of goal setting as related to diet. The detailed reporting of the dietary intervention as part of this thesis is important to allow for future replication by other studies and the ability to map intervention content to outcomes to assess effectiveness. Further, this study responds to the recent call to
researchers by Ho et al. (2012) et al. to provide more detailed reporting of dietary intervention. The delivery of the dietary intervention is discussed further in the overarching themes in section 8.7.2.

To enhance the evidence base, future dietary interventions should publish comprehensive descriptions of the intervention design. Reports should detail the rationale for intervention development and outline the important components. Specifically, further information would be useful regarding the application of a theoretical construct, pre-testing for acceptability and effectiveness, session content and use of goal setting.

8.5 Change in overweight adolescent intake
Gap: Lack of good evidence for how overweight adolescent diet changes following intervention

Objective: To assess adolescent dietary change for food groups, energy intake, nutrients, eating behaviours and adherence from post-intervention to 12 months post-intervention

Studies C and D in this thesis described the dietary changes following the CAFAP eight week intervention and during the 12 month maintenance phase. The following section is split into three parts, with the first part focusing on immediate change following intervention and the second part considering changes over the 12 month maintenance phase. Within each of these sections is a discussion of previous literature relating to short- and long-term change and how the evidence from Studies C and D builds on this. The third part of this section considers the limitations and strengths of Studies C and D, and discusses implications for future research.

8.5.1 Immediately following intervention
Immediately following the intervention, CAFAP participants increased their intake of fruit (+0.5 servings) and reduced their intake of junk food (-1.4 servings) as measured by three day food records, but vegetable intake did not change significantly. These results differed from findings using a short questionnaire, where adolescents reported significantly increased intakes of fruit (+0.4 servings) and
vegetables (+0.5 servings) and no changes to junk food intake. Energy intake assessed by food record did not change from baseline to post-intervention. Self-reported eating behaviours, such as frequency of breakfast consumption, did not change significantly during the intervention. Changes in nutrient intake assessed by food records included reductions in fat and saturated fat, along with an increase in fibre. Adherence to the key messages, as assessed using the three day food records, was highest for reducing junk food intake (69%), followed by increasing fruit intake (60%) and lastly increasing vegetable intake (49%).

### 8.5.1.1 Fruit and vegetables

There are very few prior studies that have assessed changes in fruit and vegetable intake following intervention in overweight adolescents. The American studies in this field tend to assess fruit and vegetables together as one food group, which makes comparisons with Australian and European findings difficult. Two of these American studies found no change in consumption of fruit and vegetables following intervention using a 131 item FFQ (Kong et al., 2013) and a brief screening tool developed for adults (Shaibi et al., 2012). The latter study had limited power to detect a significant change in intake as the sample only comprised 15 adolescents. The other American study by Bean et al. (2011) showed a 0.6 serving increase in combined fruit and vegetable intake using a 24-hour recall. This study did not include a control group or waitlist period to compare this change. Shrewsbury et al. (2011a) reported a significant improvement in the number of adolescents who met dietary guidelines for fruit and vegetable intake, although this was measured using a small number of questions as part of a modified FFQ. These findings are comparable to the eating behaviour question used in the current study, but the eating behaviour questionnaire is likely to be less valid than the food records, as discussed in the overarching themes in section 8.7.1. The findings from Study C add considerably to the existing evidence by using robust dietary assessment methods to measure both fruit and vegetable changes made by overweight adolescents following intervention, which has not been published to date. The significant difference in the rates of change for fruit between the waitlist period and the
intervention period provide additional support for the effectiveness of the CAFAP intervention in achieving this change.

8.5.1.2 Junk food
There are also only a small number of previous studies that have assessed changes in junk food intake following intervention. Again, the results are difficult to compare between trials because of different international definitions of junk foods. Two of the studies have reported changes in specific foods that would be classified as junk foods. For example, Shrewsbury et al. (2011a) reported a significant reduction in frequency of consumption of less healthy foods such as high fat meat products, potato crisps, and sugary drinks but there was no control group or waitlist period to compare this change to. Kong et al. (2013) found that no between-group differences existed for sweetened beverage consumption post-intervention. Two other studies described reductions in foods high in fat (Shaibi et al., 2012) and energy (Wengle et al., 2011) following intervention, but again there was no in-study comparison. Thus, the change in junk food intake for CAFAP participants during the intervention period and the significant difference in the rate of change of junk food intake compared to the waitlist period is an important finding. This reduction in junk food intake highlights the effectiveness of a food group-based approach to dietary change. Further research would benefit from using a previously definition of junk food to allow for comparisons between trials. Future studies should also include a control group or waitlist period to give context to the changes and attribute the findings to the intervention, as was possible in the current trial.

8.5.1.3 Energy intake
The majority of prior studies in overweight adolescents have reported modest, if any, changes in energy intake immediately following intervention. As has been reported for CAFAP adolescents, a lack of change in energy intake was reported in two adolescent trials (Park et al., 2007, Saelens et al., 2002) that assessed diet using two or three day diet recalls. Two other trials used FFQs to assess diet and found reductions in energy intake following intervention (Janicke et al., 2008a, Tsiros et al., 2008). Using 24-hour recalls, Bean et al. (2011) found significant reductions in energy intake immediately following intervention but had no control group or
waitlist comparison. Despite the limitations associated with comparing intakes measured using different assessment methods, in all of these trials the changes in energy intake were not different to those observed in the control group (when present), thus the findings cannot be attributed to the intervention. Further, the existing trials have all reported energy intake, but not attempted to account for the impact of underreporting. Findings from Study D build on the existing evidence by reporting more convincing energy intake data that accounts for both the impact of underreporting and the rate of energy intake change during the waitlist control period. Thus, it is likely that previous studies have overestimated the extent of energy intake change following intervention, thus the lack of change in energy intake immediately following the CAFAP intervention is a potentially more accurate indication of true intake.

8.5.1.4 Nutrient intake
Changes in specific nutrient intake following an intervention for overweight adolescents have also not been consistently reported in the literature to date. CAFAP participants reduced their intake of total fat following intervention, as did adolescents participating in interventions run by Bean et al. (2011) and Shaibi et al. (2012). However, neither of these latter studies showed a reduction in percent of total energy provided by fat as in Study D (34.8% to 31.2% of total energy), which is thought to be a more reliable measure than absolute fat intake (Hirvonen et al., 1997). There were no changes in reported total sugar consumption following the CAFAP intervention, whereas one previous trial by Davis et al. (2009b) reported significant reductions in total sugar intake in one of two intervention groups immediately post intervention. In the study by Davis et al. (2009a), sugar intake was a particular focus for intervention which may explain the reduction. However, the trial results may not be generalizable to other studies given both intervention groups had received the same nutrition component of the intervention and only one had demonstrated changes in sugar intake. Lastly, micronutrient levels did not change over 12 months in Study D suggesting that CAFAP did not have a deleterious effect on nutritional intake. In Study D, calcium intake was low (598.9mg (SD 25.0mg)) prior to the intervention, and at post-intervention increased to 606.2mg
(SD 25.5mg) but remained below recommended levels (1050mg). In a recent cohort study of Western Australian adolescents (Gallagher et al., 2014) and national survey of Australian adolescents (Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008), calcium intake was also consistently lower than the estimated average requirement, suggesting that this is a common issue in adolescents. Previous intervention studies in overweight adolescents have not regularly reported calcium intake making comparisons difficult. The findings from Study D may suggest that increasing calcium-rich foods could be a potential target for future interventions, possibly in conjunction with reducing SSB intake. The comprehensive reporting of macro- and micronutrient intake in Study D adds a weighty contribution to the evidence regarding overweight adolescent nutrient intake and nutrient change following intervention.

8.5.1.5 Eating behaviours
The findings described in this paper add to the current small body of evidence around changes in eating behaviours that may be related to overweight and obesity in adolescents. CAFAP participants reported changes in line with prior studies of overweight adolescents, in both fast food intake (DeBar et al., 2012) and SSB intake (Tsiros et al., 2008). These changes remained significant for CAFAP participants during the maintenance period; although comparisons are limited as no other studies have reported general eating behaviour changes for at least 12 months following intervention. Only one study by Nguyen et al. (2013) has reported long-term changes in specific eating behaviours, although these have not previously been shown to be associated with overweight in adolescents. For example, the study showed reduced intake of high fat meat products to once a week or less and changes in frequency of lunch consumption (Nguyen et al., 2012b). It is not clear whether these changes are meaningful in the context of managing overweight in adolescence. Thus, the findings from Study C are important to extend the limited evidence base to describe overweight adolescent eating behaviours and provide targets for eating behaviour change in future interventions.
8.5.1.6 Adherence to dietary intervention
The level of adolescent adherence to the dietary component of a multicomponent intervention is not often reported in the literature. The lack of adherence reporting has been highlighted as an important gap in knowledge and a call has been made to report this more routinely (Ho et al., 2013). The need for assessing adherence is clearly shown in the outcomes of the study by Davis et al. (2009a), who found that of two groups receiving the same nutrition intervention, only one group changed their nutrient intake as compared to the control group. Reporting the levels of adherence to the key dietary messages of this study would help to explain this surprising result. Thus, the attempt to assess adherence to the CAFAP key dietary component is a novel contribution to this area of research. In Study D, the criteria for adherence were chosen to reflect a desired magnitude of change (at least 10%). This approach may be feasible in future studies of dietary behaviours but further evaluation is required regarding mapping of adherence levels to anthropometric change, to help explain the mechanisms of weight loss.

8.5.1.7 Limitations with previous studies with post-intervention measures
All of the results from prior studies measuring diet in overweight adolescents must be treated with caution, given that none of the studies have attempted to account for the impact of underreporting. In the study by Bean et al. (2011) the authors acknowledged the potential for bias in their data collection but did not explore the effect on dietary outcomes. Underreporting was not addressed in the other studies, which has been identified as a serious limitation in the field (Collins et al., 2010). It is likely that overweight adolescents will report an intake less than their actual intake (Singh et al., 2009), and this will affect energy, food group and nutrient intakes and possibly reported eating behaviours. If underreporting is not adjusted for through exclusion of underreporters or statistical adjustments, then dietary data is likely to be misleading. This is a particular problem in overweight adolescents given the lack of evidence describing usual intake or dietary change following intervention. The findings from Studies C and D are likely to be more robust than in these prior trials, as attempts were made to quantify the bias of the results in light of the potential underreporting. Objective accelerometry data was used to estimate
energy expenditure from physical activity, which was used in the estimation of total energy expenditure. The ratio of energy intake to total energy expenditure was then used as a time-varying covariate in the analysis of the dietary data, as done previously in overweight youth (Jennings et al., 2012). This eliminated the need to exclude a large proportion of the sample, which would have introduced another form of bias (Rennie et al., 2007). Thus, Studies C and D contribute a significant amount of previously unreported information, and enhance the understanding of obese adolescent intake and how this changes following intervention.

8.5.2 Maintenance phase
During the 12 month maintenance phase, fruit and junk food changes were maintained and intake remained higher than at pre-intervention, but there were minimal changes in vegetable consumption. This differed from the self-perceived intake of vegetables which remained increased from baseline levels throughout the maintenance period. Energy intake did not change, nor did intakes of key vitamins or minerals. Fat and saturated fat intake gradually returned to baseline levels in the 12 months following intervention. There were some changes in self-reported eating behaviours during the maintenance period including increased consumption of breakfast and reduced consumption of fast food and SSBs. Other eating behaviours did not change. During the maintenance period, adherence to the key dietary intervention messages decreased. However, the majority of participants who completed the entire 12 month maintenance period continued to adhere to the dietary messages. Reducing junk food intake remained the message most adhered to. In summary, some positive dietary changes were seen following intervention and food group changes were maintained for 12 months. The majority of the nutrient changes were not maintained, but several eating behaviours improved during this time.

8.5.2.1 Food groups (fruit, vegetables and junk food)
Long-term food group changes have been very rarely reported in overweight adolescent interventions. There are no published records of fruit and vegetable changes at 12 months post-intervention, and no thorough assessment of junk food changes. There are however, two studies that provide long-term (at least 12 months
post-intervention) data regarding changes in some examples of junk food (Nguyen et al., 2013, Coppins et al., 2011). At 22 months following intervention conclusion, Nguyen et al. (2013) reported less frequent consumption of high meat products, as compared to baseline measures. There were no other maintained dietary changes relating to ‘junk foods’. At 12 months following intervention conclusion, Coppins et al. (2011) found that potato crisp consumption was higher (87g per week) in the group who had completed the intervention 12 months prior, as compared to the group who had just completed the intervention (25g per week). The reporting of potato crisp consumption as the only food or eating behaviour change makes comparisons with other studies particularly different. Neither of these studies have reported whole food groups, nor provided adequate dietary detail to give context to the limited findings. Thus, the findings from Studies C and D in this thesis provide a substantial amount of novel information regarding long-term changes to food group consumption in overweight adolescents.

8.5.2.2 Energy
Of the previous adolescent obesity interventions discussed in this thesis, none have reported energy intakes at 12 months post-intervention. Thus, the findings from Study D make a new contribution to the evidence base. The lack of change in energy intake across the study is surprising, particularly given the consistent reduction in junk foods which tend to be high in energy. However, there were only modest changes reported for BMI z-scores and physical activity, so it is unlikely that energy intake had any impact on the energy balance equation. Thus a lack of change in energy intake may explain why there weren’t greater changes in BMI z-scores. This highlights one of the main limitations of using the food group-based approach, specifically the assumption that engaging in healthier eating behaviours will result in a reduction in energy intake. Theoretically, adhering to the key messages about eating more fruit and vegetables and eating less junk food could result in a reduction in energy intake by reducing the energy density of the diet, however this is not guaranteed. It is possible that adolescents may compensate for this change by eating greater volumes of other core foods or reducing their energy expenditure. Regardless, it is accepted that an improvement in diet quality will result in improved
health outcomes (Ross and Bradshaw, 2009) and reduced risk of chronic disease (Gaesser et al., 2011), independent of weight change.

8.5.2.3 Nutrient intake
No other multicomponent interventions for overweight adolescents have reported nutrient intakes at 12 months post-intervention. Although nutrient intake was generally not improved at this time point, there is no evidence that the dietary component of CAFAP had a negative impact on the diet of overweight adolescents. There were no significant reductions in the key nutrients that were included in the analysis as markers of nutritional adequacy. Calcium intake remained low (663.9mg (SD 34.0mg)) at 12 months post-intervention, but was slightly higher than at pre-intervention (598.9mg (SD 25.0mg)). This reinforces the potential to promote food sources of calcium in future interventions. Iron and vitamin C intake did not change throughout the study. Improvements in fibre intake were sustained during the maintenance period. This offers support for the food group-based approach used in CAFAP, as opposed to a diet or energy prescription approach. This is particularly important because adolescents who ‘diet’ tend to engage in behaviours that are actually associated with weight gain, such as reducing the frequency of breakfast consumption (Neumark-Sztainer et al., 2007).

8.5.2.4 Eating behaviours
As with most other components of diet, there is a lack of detailed reporting of eating behaviour change at least 12 months post-intervention in overweight adolescents. Only one previous study has reported a change in eating behaviours (Nguyen et al., 2013), specifically the frequency of lunch consumption. Thus the reporting of eating behaviours in Study D makes a novel contribution to the scant evidence. The only eating behaviour changes to occur during the maintenance period and be maintained at 12 months post-intervention were reductions in frequency of consumption of fast food and sweetened beverages. There were no negative changes in eating behaviours, further supporting the conclusion that the dietary component of CAFAP did not cause harm.
8.5.2.5 Adherence
As at post-intervention, there are no studies to reporting adherence to the key dietary messages at 12 months post-intervention. Thus, the findings from Study D make a significant contribution to the evidence. At both immediate post-intervention and 12 months post-intervention, ‘eat less junk food’ was the message adhered to by the greatest proportion of participants. Previous research in younger overweight children (Epstein et al., 2008) showed that greater reductions in high energy foods (junk foods) were associated with reduced BMI z-scores. More evidence is needed in overweight adolescent groups to show a consistent link between a reduction in junk foods and BMI z-scores.

8.5.2.6 Limitations with previous long-term studies
Long-term reporting of dietary intake is impacted by the same limitations as the short-term data, with studies not accounting for the impact of underreporting. Only two studies reported dietary intake at least 12 months post-intervention and Coppins et al. (2011) did not account for potential underreporting in the seven day food records, whilst Nguyen et al. (2013) did not use a dietary assessment method that assessed energy intake, thus assessment for the impact of mis-reporting is difficult. Therefore, the findings from Studies C and D contribute novel information about energy, food groups, nutrient intake and eating behaviours that have been adjusted for underreporting. This is particularly important to set an example for future dietary interventions, but also to start to understand what overweight adolescents eat and how this might be changed. Further evidence is needed to fully understand these issues, but the current findings suggest that long-term changes can be sustained in fruit and junk food intake. Further, some eating behaviours, such as eating breakfast more regularly, can be successfully encouraged in this group.

8.5.2.7 Benefits of detailed reporting of diet
The reporting of detailed dietary data for 12 months following the CAFAP intervention also extends the evidence base by considering diet across all components of energy, food groups, nutrients and eating behaviours, rather than just reporting a small component. The comprehensive reporting in Studies C and D
provide sufficient context to more accurately interpret dietary change and increase confidence in the results. For example, the post-intervention food record reductions in fat and saturated fat in Study D are consistent with reductions in junk food as reported in the Study C. Similarly, increases in fibre intake in Study D reflect patterns of fruit and vegetable intake previously described in Study C, although there appears to be room for further improvement in both food groups and nutrient intakes. The findings also suggest that a food group-based dietary intervention can positively impact food and nutrient intake and eating behaviours in overweight adolescents.

Only three other studies have provided detailed dietary data across three of the four sub-sections of diet (Tsiros et al., 2008, Saelens et al., 2002, Bean et al., 2011) and all have been for less than 12 months following intervention. These trials have also used a food group-based healthy eating dietary intervention. Two studies (Tsiros et al., 2008, Bean et al., 2011) showed modest but positive short-term changes in three components of diet, whereas one trial showed no change across three components of diet (Saelens et al., 2002). The findings from CAFAP build on this existing limited evidence by describing the whole diet to provide a more comprehensive understanding of what overweight adolescents eat. Detailed reporting gives context to results that may be misconstrued if only a small aspect of diet is measured for change, and gives confidence to such findings. For example, a reduction in the frequency of fast food intake is a positive outcome; however, this does not mean that the dietary intervention was effective if intakes of other junk foods increased in the same period. Further, a single item assessing intake of fast food is likely to be more influenced by bias than if using other more thorough dietary assessment methods (Kirkpatrick et al., 2014). The difference between self-perceived intake measured by a questionnaire and self-reported intake in a food record is discussed further in the overarching themes section 8.7.1. Future trials in overweight adolescents that include a dietary component would benefit from more comprehensive reporting of diet to compare to the CAFAP findings. This is important to evaluate the effectiveness of dietary interventions and guide future planning.
8.5.3 Strengths and limitations

A strength of Studies C and D was the robust assessment of diet, including the use of dietary assessment methods to assess both diet and eating behaviours, and adjustment to counter the impact of underreporting. There are a number of indicators that a reasonable level of reporting occurred throughout the duration of the CAFAP study. Energy intake did not change significantly throughout the study, which reflects the stable weight of participants during the same time period and also suggests that there was no evidence of a gradual omission of reporting over time (Goris et al., 2001b). Further, the rate of change of energy intake did not differ between the waitlist control period and the intervention or maintenance periods for CAFAP participants, which gives confidence to the lack of other findings. In Study C, servings of fruit, vegetables and junk food during the maintenance period either stabilised or regressed towards baseline levels, though non-significantly. This may suggest low levels of selective reporting. The results also reflect current national data, particularly relating to percent energy contribution by macronutrients (including fat) (Commonwealth Scientific Industrial Research Organisation (CSIRO) et al., 2008) and junk food consumption (Rangan et al., 2008). This national data was assessed for underreporting using a number of different methods, and the authors found the prevalence to be relatively low (5.0-6.7%) when compared to other studies (Rangan et al., 2011). Further analysis showed that both core and non-core foods were underreported by low-energy reporters in this national study (Rangan et al., 2014). Thus, as underreporting was equivalent between food groups and the macronutrients were comparable to national data, the lack of differences between the datasets suggests that the CAFAP data likely reflects an accurate picture of overweight adolescent diet.

Although the findings from Studies C and D are likely good representations of the intake of this particular group of overweight adolescents, there are a number of limitations that reduce the generalizability of the data. This study had a high level of attrition, as is common in weight-related interventions (Skelton and Beech, 2011). To overcome this, analyses were undertaken for all participants who had been assessed at a minimum of two time-points. The waitlist control design provided a
within-subject control period to compare changes made during the intervention and maintenance periods. There were some dietary changes observed during the waitlist period, which might have been as a result of enrolling in CAFAP, however the comparisons of the rates of change across the study were greater than those seen in the waitlist period. This gives confidence to the results and suggests that the intervention had a positive effect on diet. Further, the participants included a large proportion of Caucasian females from mainly low-middle socioeconomic backgrounds, and this homogeneity limits the generalizability of findings to other groups with different backgrounds.

8.5.4 Implications for research and practice

Despite the limitations associated with measuring adolescent diet, findings from this thesis and other overweight adolescent interventions seem to suggest that modest short-term dietary changes which dissipate over time are achievable. What remains unknown is why the dietary change was so small, particularly when baseline dietary assessments suggest an overall poor diet with plenty of opportunities for improvement. There are a number of potential reasons for this including imprecise methods of dietary assessment, sample sizes that are too small to detect meaningful differences, poorly designed dietary interventions, poor adherence to the dietary intervention or the difficult nature of making dietary change. It is possible that a combination of these factors impact on dietary change and well-designed future studies will be critical in understanding the mechanisms for change. This in turn will guide the development of more efficacious dietary interventions. In the studies described in this thesis, the selection of two appropriate methods of dietary assessment, an adequate sample size to detect significant short-term changes and adjustment for underreporting gives confidence in lack of significant findings over the long-term. Although the findings do not suggest substantial dietary change, it might be this lack of change that points to the next focus for researchers. Thorough evaluations of the effectiveness of dietary interventions might be where future research is most strongly needed. Further, there needs to be more well-designed studies to investigate how to overcome the genuine difficulty that participants experience with achieving long-term dietary
change. To address these issues, future research should include comprehensive dietary assessment methods and report detailed dietary outcomes as compared to those of a control group or waitlist control period. Further, this reporting should include an assessment of underreporting and appropriate statistical adjustment. This will give confidence to the dietary findings, provide evidence for how to change adolescent diet and improve the efficacy of future dietary interventions.

8.6 Maintenance support for overweight adolescents

Gap: Lack of evidence about how to best support overweight adolescents in the maintenance period following intervention

Objective: To evaluate the experiences of adolescents receiving text messaging support during the maintenance period

Study E described overweight adolescent experiences of text messaging support offered during the maintenance phase. The text messages were grounded in self-determination theory and reflected the key messages delivered during the intensive eight week intervention. Overall the text messaging was not positively received. Adolescents described a sense of shame when receiving the messages and didn’t like to feel that they were being compared to adolescents. These were unintended consequences and the opposite of adolescent experiences during the eight week intervention. This potentially highlights the different approaches needed to achieve adolescent engagement versus encouraging behaviour change. The adolescent experience was not as positive as reported in previous studies in overweight adolescents, although most prior studies involved adolescents in the planning of the intervention rather than an evaluation of the intervention as delivered. However in Study E, adolescents were unable to describe their preferences or new ideas for future contact without returning to ideas that they had previously rebuffed. This is a barrier for future text messaging interventions in overweight adolescents. The following section includes a discussion of how the findings from Study E build on previous research that has used text messaging with overweight adolescents during the maintenance period. Given the small amount of research regarding text messaging with overweight adolescents, this also includes a comparison to other
methods of contact used during the maintenance period and the acceptability of
text message interventions for non-overweight adolescents. This is followed by a
summary of the strengths and limitations of this study, and implications for future
research and practice.

8.6.1 Frequency
In Study E, adolescents were sent a text messages three times per week for three
months during the maintenance period, with additional fortnightly telephone
contact. The frequency of text messaging in Study E was perceived as too often by
adolescents. In the only other adolescent study to offer text messaging during the
maintenance period, the authors suggested that the contact dose (one per month)
was too low (Nguyen et al., 2013). One other study has examined how overweight
adolescents experience daily text messaging in relation to treatment, but this
occurred during the intervention period rather than the maintenance period
(Woolford et al., 2010). Although the authors concluded that this dose was
acceptable to adolescents, the text messaging occurred at a time when adolescents
were also receiving significant additional support for change. Thus, the findings
from Woolford et al. (2010) are not able to be generalised to adolescents receiving
text messages during the maintenance period. Study E furthered the understanding
of text messaging for overweight adolescents during the maintenance period by
showing that three times a week was too frequent for text message contact. This
suggests that further research needs to be conducted with overweight adolescents
during the maintenance period to determine an ideal frequency for contact
somewhere between once a month and three times a week.

8.6.2 Inadequacy of pilot testing of text messages
Another important contribution of Study E was the identified differences between
pilot testing and post-intervention evaluation when working with overweight
adolescents. Previous studies with overweight adolescents have been done prior to
intervention, to assess acceptability to adolescents and include them in the
refinement of text messages (Woolford et al., 2011a). Adolescents were reported to
be particularly enthusiastic about receiving text messages, as were the CAFAP
adolescents before the text messaging began. The unexpected shift in attitudes
towards the text messaging seemed to occur early in the maintenance period for CAFAP participants. At the three month post-intervention focus groups, adolescents suggested some changes to be made to the wording of text messages, but agreed that it would still be annoying to receive texts from the CAFAP team. This is particularly important because it suggests that overweight adolescents are not able to predict their own responses to text messages before they have begun to receive them frequently.

8.6.3 Other forms of maintenance support
There have been a small number of studies in overweight adolescents that have used methods other than text messaging to contact adolescents during the maintenance period. Davis et al. (2012) showed that contact with adolescents via booster sessions or newsletters had the same effect on outcomes during the maintenance period. Booster sessions offered twice a month were also used by Savoye et al. (2011) with good effect, compared to a control group that received no contact. Lloyd-Richardson et al. (2012) used enjoyable social activities to stay in contact with adolescents, but did not evaluate the usefulness of this for adolescents. Tsiros et al. (2008) used phone calls to contact adolescents during the maintenance period but this was also not evaluated post-program. Deforche et al. (2005) found that weekly contact by mail or phone was effective at supporting physical activity and weight changes, when compared to a control group. However, these authors did not evaluate the adolescent experience of this contact. Study E in this thesis provided detailed information about how adolescents experienced ongoing contact during the maintenance program, which is useful to future researchers and health professionals in the planning of treatment to meet the unique needs of overweight adolescents.

8.6.4 Loss of engagement
The findings raise an important issue regarding unintended consequences of text messaging. In this study, text messaging appeared to alienate adolescents and may have had a negative impact on their perception of CAFAP. By engaging adolescents in meaningful discussion groups, this study has described how overweight adolescents respond to contact and shown that text messages designed to
encourage behaviour change may discourage adolescents from staying engaged with the intervention.

8.6.5 Unique needs of overweight adolescents
Evaluations of text messaging in healthy-weight groups may not be applicable to the experiences of obese adolescents. Previous studies in healthy weight, or non-obese diabetic adolescents have shown positive reactions to behaviour change text messages. For example, daily text messages were well-received by diabetic adolescents during a 12 month study (Franklin et al., 2006). In another study, focus groups in healthy weight adolescents suggested a preferred message frequency of less than two messages per day (Hingle et al., 2013), which is still considerably more frequent than what was used in CAFAP. There may be limited conclusions that can be drawn from studies of text messaging in non-obese populations, as it seems that obese adolescents are a unique group who respond differently to reminders about healthy behaviours.

8.6.6 Text message tone
In Study E, adolescents described the text messages as being too formal and impersonal. Previous research has highlighted the importance of casual and natural language coming from research team staff (Woolford et al., 2011a). One of the difficulties with developing text messages is being able to convey a personalised and relevant message using a short style of communication. The poor perception of CAFAP text messages may indicate that this was not achieved in Study E. Another explanation might be the loss of personal contact with CAFAP staff. During CAFAP, the adolescents formed strong relationships with program staff and other adolescents and rated this as one of the most enjoyable aspects of the program. The text messages during the maintenance team were signed off ‘From the CAFAP team” but this might have been perceived as a loss of personal contact from staff that had supported adolescents throughout the previous eight week intervention. Previous research into maintenance of behaviour change in adults has highlighted the importance of meaningful contact between clinicians and participants (Jeffery et al., 2000, Turk et al., 2009, Svetkey et al., 2008). Thus, a generic sign off from the team might have highlighted the loss of direct contact. Future text messaging
interventions would benefit from understanding how the sender of the message influences the response of adolescents.

8.6.7 Facebook support
CAFAP tried to pre-empt this issue with the loss of relationships, by offering adolescents regular telephone contact and by establishing an online social communication hub using a private group on Facebook. However, adolescents were very difficult to engage in either of these processes. Facilitators were known to the participants from assessments and had built rapport over the preceding five months, but were not the same staff who delivered the face-to-face intervention. These facilitators found it very difficult to engage adolescents in conversations on the telephone and the satisfaction ratings for the Facebook support were lower than for the text messaging support. When the Facebook group was set up, anecdotal evidence from adolescents suggested that they were concerned other people outside of CAFAP might have been able to see their interaction with the group. However, despite confirmation from the team that the group was completely private, uptake remained poor. These findings emphasise the importance of meaningful relationships between adolescents and treatment staff, and highlight the need to understand perceived barriers that prevent adolescent engagement.

8.6.8 Strengths and limitations
The strengths of Study E include an appropriate qualitative design to provide novel and detailed information about overweight adolescents’ experience of text messaging during the maintenance period. This is a highly under researched area and the findings highlight a number of key issues that are critical to future interventions. The limitations of Study E relate to the small number of participants involved in the focus groups, however, after only four focus groups it was evident that saturation had been reached. The inclusion of parent views in the study also provided confidence that adolescents were discussing their true responses, rather than what they thought the researchers wanted to hear. Another limitation was the lack of a control group during the maintenance period, thus adolescent responses could not be mapped to their behaviours. Although this study was able to provide a
description of adolescent experiences, it cannot comment on the effectiveness of the text messaging during the maintenance period on behaviour change.

8.6.9 Implications for research and practice
Future research should identify an acceptable frequency of text message contact for overweight adolescents, which may lie between once a month and three times a week. It is critical that evaluation occurs after overweight adolescents have actually received the text messages, to understand their true responses rather than how they think they might respond. This is not often done in current research and the negative responses gleaned in this study highlight the need to investigate unintended consequences associated with text messaging. For overweight adolescents, these consequences may be related to feelings of guilt and shame, but text messages may also have the potential to damage the links between the adolescents and the program. Based on the results from this study, text messaging may not be the most effective way to maintain contact with adolescents and encourage behaviour change. Thus, future research is needed to evaluate other innovative ideas to support overweight adolescent behaviour change during the maintenance period.

8.7 Overarching themes to emerge from the thesis

8.7.1 Challenges in obtaining a robust assessment of obese adolescent diet
One of the overarching themes to emerge from the studies in this thesis is around the significant challenges associated with collecting meaningful dietary data from adolescents. An important finding related to this theme was the differences observed in food group data as collected using a food record and a short dietary questionnaire. Adolescents participating in CAFAP rated their own intake of fruit and vegetables very differently to how they recorded their intake using the food records. For example, adolescent intake of vegetables was estimated from the food records to be 1.3 (SD=0.1) servings per day at pre-intervention, compared to a self-perceived intake of 2.4 (SD= 0.1) servings per day. This difference between assessment methods of more than one serving is quite considerable given the
vegetable servings from the food record were only slightly more than one serve. Following intervention there was no change as measured by the food records but a self-perceived change of 0.5 serves, which was statistically different to pre-intervention levels. This further demonstrates the difference between estimated intake of vegetables using different assessment methods. At 12 months post-intervention, food records showed no change in vegetable intake but the self-rated change was significantly different with an increase from baseline of 0.9 serves. Thus, the food records showed no change in vegetable intake but the brief questionnaire showed significant change. This highlights a lack of agreement between dietary assessment methods for both estimates of total intake, and estimates of change following intervention. In this study, there were a number of reasons to have confidence in the findings from the food records, as discussed earlier in section 8.3.4, although it is only assumed that the food records capture usual intake. In Study C it was concluded that CAFAP had little effect on vegetable consumption, because the three day food record provided a more robust assessment of diet. However, if the short questionnaire was the only dietary assessment method used in this study, then the dietary impact conclusions would be dramatically different.

8.7.1.1 Factors influencing dietary reporting
Reasons for this difference in reported intake are not clear. There is the potential that adolescent reporting was affected by social desirability, that is the tendency to report intakes that will be favourably viewed by others (Hebert et al., 1995). Social desirability has the potential to impact on any dietary assessment (Hebert et al., 1995), so this would also be expected in the food records. However, the dietary questionnaire measured fruit and vegetable intake more openly than in the food records. The questions regarding fruit and vegetable intake were directly reflective of the key CAFAP messages for healthy eating. It is possible that adolescents reported an intake that they were aiming for, or was in line with the program messages. In other data not presented in this thesis, adolescents participating in CAFAP reported increased motivation for healthy eating following intervention (Fenner, 2014). They also reported high levels of goal attainment around increasing
fruit and vegetable intake (Fenner, 2014). These attributes are particularly important for dietary change (Kumanyika et al., 2000), but do not appear to reflect any actual intake changes observed in this cohort. It may be possible that adolescents were more motivated and were more aware of the importance of fruit and vegetable intake, thus they perceived their intake had changed. Perhaps the results from the short questionnaire reflect adolescent goals/knowledge/awareness rather than intakes. However, this does highlight the potential limitations of using dietary assessment measures with only a small number of items.

8.7.1.2 Underreporting
Previous studies involving more comprehensive methods of dietary assessment may also not be representative of overweight adolescent intake, particularly if the analysis has not accounted for the impact of underreporting and misreporting. This is of high importance given the majority of adolescent studies reporting dietary intake do not address underreporting at all (Kitzman-Ulrich et al., 2009, Coppins et al., 2011, Wengle et al., 2011, DeBar et al., 2012, Nemet et al., 2006, Tsiros et al., 2008, Shaibi et al., 2012, Janicke et al., 2008a, Davis et al., 2009b, Karner-Rezek et al., 2013, Kong et al., 2013, Ball et al., 2011, Park et al., 2007, Saelens et al., 2002). This has a direct impact on interpretation of dietary data for overweight adolescents, and impedes future study replication.

8.7.1.3 Importance of detailed dietary assessment
The findings from this thesis are important when considering the impact of conclusions drawn in previous studies, particularly those that have not included comprehensive dietary assessment. Two previous adolescent studies reporting fruit, vegetable and some junk food intakes have used short diet-related questions to assess food group intake. It is not clear from the Nguyen et al. (2012) study whether the fruit and vegetable data came from the 15 item FFQ or the additional diet-related questions. The study by Shaibi et al. (2012) used a short screening tool to measure intakes of fruit, vegetables and high fat foods. These short questionnaires may have been strongly affected by systematic error (Kirkpatrick et al., 2014), and so the findings may not reflect the true mean of the group. Thus, there is the potential that these assessment methods may not be good representations of
adolescent intake nor change following intervention. This is very important because of the current lack of data regarding what overweight adolescents eat and how this can be changed. If the data from short questionnaires does not accurately reflect adolescent diet, then it is possible that future interventions could be based on inaccurate estimates of adolescent diet and unrealistic expectations of dietary change. The results from these and other studies that include short dietary questions as measures of diet must also be considered in light of these measurement limitations.

There are also inherent limitations with the data of studies that have only reported small components of diet. No prior studies of interventions for overweight adolescents were found which reported all four components of diet identified from previous literature in this thesis, namely energy intake, food group intake, nutrient intake and eating behaviours. This is an issue because reporting of only one component does not help with interpretation of how the diet changed following intervention. For example, an increase in vegetable intake might be a positive result, particularly if vegetables have displaced a more energy-dense and less nutritious food. However, the importance of this finding may be weakened by an associated increase in junk food intake or fat intake, possibly from high fat sauces or unhealthy cooking practices. Detailed dietary reporting is important to understand what dietary changes were actually made and how this might be relevant to other adolescents in future interventions.

8.7.1.4 Implications for future research and practice
The studies in this thesis add important evidence to suggest that short dietary questionnaires may not reflect of true adolescent intake, particularly of food groups. While these assessment methods are tempting to use with adolescents because of their low cost and low burden, this research shows that they cannot be assumed to accurately reflect intake or change in intake. Instead, short dietary questionnaires may be employed to understand adolescents’ perception of their own intake. Such questionnaires do provide useful data to support more comprehensive methods of dietary assessment, but the findings from this thesis show they may not be suitable as a stand-alone method of assessing diet. A lack of
consistent assessment and consideration for the effect of underreporting on dietary data is another limitation of the existing evidence regarding adolescent dietary change. Future research should incorporate a method of assessing underreporting and accounting for it as necessary. Further, reporting only a small component of diet has the potential to provide misleading findings. Thus, recommendations for future research include more comprehensive reporting of adolescent diet across energy, nutrients, food groups and eating behaviours. This gives context to results that may be misconstrued if only a small aspect of diet is measured for change. The use of two methods of dietary assessment, an attempt to address underreporting and a measure of adherence to the dietary assessment will also improve the quality of dietary data reported in the future.

8.7.2 Challenges in developing and implementing a dietary intervention for obese adolescents
The future improvement of dietary interventions is hampered by a general lack of evidence regarding what overweight adolescents eat, a lack of understanding about how best to modify this, and limited reporting of dietary intervention details and outcome details. The ability to use dietary outcomes to assess intervention effectiveness is further limited by the lack of attempts to account for the impact of underreporting on the data. This section describes the experiences of delivering the dietary component of CAFAP, using observational evidence from the trial and qualitative evidence collected from adolescents and parents following completion of the intervention. A discussion of the lessons learned will include ideas for future interventions.

8.7.2.1 Positive aspects of the CAFAP dietary intervention
Both adolescents and parents reported enjoying the healthy eating sessions, as shown by the qualitative post-program evaluation data. Anecdotally, the topics appeared to generate discussion between family members and participants reported developing new skills. The three food sessions most positively received were the food labelling session using real food labels, the portion size session using visual aids for estimating appropriate portions and the food preparation session. These sessions were also the most hands-on sessions, and seemed to be the
concepts that adolescents could most easily recall post-intervention. To explain this, it is useful to refer back to the theoretical underpinnings of CAFAP to consider how the design of such sessions may have met adolescent needs (Fenner et al., 2013). The practical sessions allowed for opportunities to practice new skills and may have increased adolescents’ sense of competence. Practical topics such as food labelling and food preparation may have allowed adolescents’ to engage at their own pace, suiting their need to feel they could choose for themselves. Further, the interactive style of the sessions allowed facilitators to engage with participants and address questions that naturally arose, thus contributed to their sense of belonging (Deci and Ryan, 2000).

8.7.2.2 Proposed changes to the CAFAP dietary intervention

The delivery of the dietary intervention would benefit from some modifications if it were to be offered as an ongoing health services. Given the overall poor diet of overweight adolescents’ (Morley et al., 2012), the intervention was designed to address multiple components of diet. However, based on participant and facilitator experiences of CAFAP, it is likely that there was too much information to cover. Adolescents reported that there was too large a focus on activities that involved thinking and writing. This reminded adolescents of school and made them resistant to engage in the sessions, particularly if they had to write something down. Previous research has also showed that parents and adolescents who dropped out of a healthy lifestyle program perceived that there was too much information to learn (Brennan et al., 2012), which is consistent with the experiences from CAFAP. Future delivery of CAFAP may benefit from less of a focus on developing knowledge. Thus, it is particularly important for future interventions and health services to offer activities and incidental learning opportunities based on a small number of topics that are interesting and not overwhelming for adolescents.

During the CAFAP food sessions it was evident to facilitators that adolescents already knew about the importance of eating more fruit and vegetables and eating less junk food. These healthy eating messages are covered at school in the Australian Curriculum for Health and Physical Education (Australian Curriculum Assessment and Reporting Authority, 2012). To make the intervention more
relevant, the use of the targeted dietary messages proposed in Study B may be useful in providing novel teaching points for facilitators to use with adolescents. Further, less of a focus on sharing knowledge and more of a focus on goal setting and identifying individual-specific barriers to change might be useful in future intervention delivery.

**8.7.2.3 Challenges with goal setting**

To assist with goal setting, adolescents were provided with an estimate of their current activity and food behaviours, as taken from the three day food records and physical activity measures completed at baseline. This was designed to tailor the goal setting process to each adolescent and help them to set achievable goals based on their current habits. Following participation in CAFAP, adolescents reported achieving their healthy eating goals, despite very modest changes in food group and nutrient intake data reported in food records. There appears to be a gap between what they thought they were eating and what they were actually eating. It is possible that adolescents perceived themselves to be eating more healthily after becoming more aware of the CAFAP key messages. Thus, a more targeted and individualised approach might be necessary to increase the relevance of healthy eating messages and assist with goal setting. Study B highlighted times and days when fruit and vegetable intake was likely to be low and junk food intake was likely to be high. This information has the potential to form the basis of targeted messages that are likely relevant to overweight adolescents, to guide them in their goal setting. By suggesting times and days that are common high risk periods for junk food consumption for all adolescents, or have a low likelihood of fruit and vegetable consumption, the approach remains in line with self-determination theory. Adolescents could still choose their own goals and maintain their sense of autonomy but also be provided with structure to help them set realistic goals (Shilts et al., 2004a). In this way, adolescents would be better supported to set relevant and specific goals, which is potentially one of the most efficacious ways to promote healthy behaviour change (Locke and Latham, 1990, Shilts et al., 2004a).
8.7.2.4 Importance of a strong theoretical background

The use of self-determination and goal setting theories allowed the dietary component to be smoothly integrated with the physical activity and attitudes components of CAFAP. This took the focus away from telling adolescents and parents how change their diet, and encouraged participants to choose goals that they were motivated to achieve, based on what they had learnt about healthy eating. Parents also had a number of behaviours to practice based on self-determination theory that were different from their adolescents. The definition of a clear role for parents in CAFAP was particularly useful, as parents have previously reported that they lacked confidence in helping their adolescent to make changes (McManus et al., 2012). The concepts associated with goal setting around healthy eating were particularly difficult for some adolescents and parents to grasp. To address this, there were several sessions dedicated to teaching goal setting, and three facilitators were present in the initial sessions to help individuals. Regardless, goal setting remained a challenge for many participants and this may have reduced the effectiveness of this approach.

8.7.2.5 Difficulty identifying appropriate dietary targets for change

There is a lack of strong existing evidence to suggest which aspects of adolescent diet are most easily changed and maintained. Overall, more than half of CAFAP participants adhered to the dietary messages of the intervention (eat more fruit and vegetables, eat less junk food). However, adolescent dietary change was modest following intervention and most changes were not sustained over the 12 months following intervention. It is accepted that dietary change can be particularly hard to achieve, especially because eating is not an optional habit and a large number of food choices must be made on a daily basis (Kumanyika et al., 2000). This is further complicated by the need for ongoing commitment to improving diet, as short-term or sporadic adoption of healthy behaviours is unlikely to result in long-term change (Skelton and Beech, 2011). Future research is needed to identify which aspects of adolescent diet are the most important to target, and how to better support these changes long-term. This evidence will need to come from interventions reporting detailed descriptions of the dietary intervention used and comprehensive reporting of dietary intake and change.
8.7.2.6 Implications for research and practice
Future dietary interventions for overweight adolescents need to be informed by better evidence. This could include stronger evidence regarding typical overweight adolescent consumption habits and findings from detailed evaluation of dietary interventions. A focus on a small number of practical topics may be beneficial in the delivery of future dietary interventions, particularly if developed in line with an appropriate theory. The use of diet-related goal setting also likely plays an important role in future interventions, however, the concepts can be difficult for adolescents to fully grasp. The use of targeted messages about overweight adolescent consumption patterns may be useful to guide the goal setting process.

8.7.3 Challenges in supporting maintenance of healthy behaviours in obese adolescents
The third overarching theme to come out of this thesis relates to the difficulties with helping adolescents to maintain healthy behaviour change following intervention. The maintenance program following CAFAP was informed by the formative research undertaken in Stage One (see Chapter One) with adolescents, parents and stakeholders. The program was designed to reflect the key messages that had already been taught during the intervention, and was based on the same theoretical underpinnings as the intervention. The contact tapered off over time in an attempt to reduce reliance on contact from the team. Despite the planning involved in the delivery of the maintenance contact, the CAFAP maintenance support was not particularly successful. The text messaging support offered to CAFAP participants was not well received and contact three times a week was perceived as too frequent. The Facebook and telephone contact logs did not suggest high levels of interaction. There were only a small number of positive outcomes sustained during this maintenance period, so it is likely that the maintenance program evaluated in Study E was largely ineffective. However, the lack of a control or comparison group during the maintenance period limits conclusions regarding effectiveness.

8.7.3.1 Lack of consistent evidence
A general lack of research regarding the maintenance period in overweight adolescents is the first major barrier to offering efficacious maintenance programs.
No existing studies have been identified relating to barriers and enablers that may affect the delivery of a maintenance program. Of the adolescent obesity interventions described in section 2.3 of the Chapter Two, only five had incorporated some kind of maintenance period where contact was offered to adolescents at a lower frequency than during the intensive intervention (Davis et al., 2012, Kornman et al., 2010, Lloyd-Richardson et al., 2012, Tsiros et al., 2008, Savoye et al., 2011), with one additional pilot study evaluating a maintenance treatment program (Deforche et al., 2005). These studies described similarly low impact of the maintenance program following adolescent obesity interventions, with only one study able to show that the maintenance component was effective at sustaining change (Deforche et al., 2005). One study concluded that the dose of electronic contact (one text per month) was not frequent enough (Nguyen et al., 2013) and another study concluded that booster sessions had the same impact on behaviour as a regular newsletter sent to adolescents (Davis et al., 2012). Thus, the findings from Studies A and E add further evidence, particularly relating to dose and mode of contact, to guide future interventionists in their design of maintenance programs.

8.7.3.2 Design of maintenance support
In addition to the existing inconclusive literature regarding maintenance support, the findings from this thesis highlight a number of challenges for future researchers and health professionals to consider when concluding healthy lifestyle interventions. The first major issue is the design of maintenance programs. Given the difficulty in proving the effectiveness of maintenance contact, future interventions should consider employing a control group during this period; however this raises some ethical issues regarding equality of service. Another option is to randomise participants to different maintenance programs to compare their effect on sustaining long-term change. However, this method does not provide a true measure of effectiveness, rather a comparison of two approaches. For example, Davis et al. (2012) compared two different modes of maintenance support, but could not conclude that either was effective, rather that they just produced the same outcomes.
8.7.3.3 Unclear expectations for change during maintenance

The literature review in Chapter Two draws attention to the lack of good evidence for targeted and efficacious intervention design for overweight adolescents. It is possible that previous studies have invested more time and resources in the design of this component, rather than in the maintenance component. Despite differences in intervention designs, most adolescent interventions result in modest positive changes (Oude Luttikhuis et al., 2009). However, the lack of sustained dietary change in Studies C and D provide support for giving greater priority to the maintenance program. There are two key issues to overcome in the design of maintenance programs. Firstly, there remains a lack of guidelines for how to best offer support to adolescents following intervention. At this stage, researchers and health professionals are required to make a best guess about what to include in their maintenance period. These services need to be comprehensively reported in the literature to facilitate replication and build the evidence base. The findings from Study E have started this process. Secondly, there is a lack of long-term data regarding anthropometric and behaviour changes that can be expected following overweight adolescent interventions. It is unclear whether some regression should be expected during the maintenance period, or whether modest changes should be maintained or even improved upon. Thus, it is difficult to distinguish between the natural trajectory following intervention and the impact of a maintenance program.

8.7.3.4 Frequency and mode of contact

The desirable frequency and mode of contact during the maintenance period remains unknown for overweight adolescents. Thus, the level of resources required to deliver a maintenance program remains unknown. The maintenance program following the CAFAP intervention was designed to require a low level of resources to implement. A computer program was used to deliver text messages at a pre-determined time, so researcher time was only needed to develop the text message content and set up the program. However, the adolescents and parents in this study perceived the text messages to be too impersonal. This has implications for future research, because face-to-face or telephone contact requires a much larger investment of researcher time and becomes less cost-effective. Previous research in adults has suggested that face-to-face strategies are important in the maintenance
of weight loss (Turk et al., 2009, Jeffery et al., 2000, Svetkey et al., 2008) but it is unclear whether this will also apply to adolescents. However, the findings from Davis et al. (2012) provide support for the use of newsletters in preference to booster sessions. The impersonal nature of newsletters did not seem to be an issue for the participants of that study, which conflicts with CAFAP participant views about text messages being too impersonal. There is potential that the newsletters contained a richer level of information which was useful for participants or perhaps the newsletters and booster sessions were equally ineffective. This highlights the need for comprehensive post-intervention evaluation with adolescents to develop an understanding of their preferences. The findings described in Study E are strengthened by the level of detail provided by overweight adolescents regarding their response to the text messages. Further research comparing different modes of maintenance contact, with thorough post-program evaluation will be important to guide future interventions.

8.7.3.5 Implications for research and practice
Further research is needed to understand how to offer effective support to overweight adolescents during the maintenance period. This research should include a strong study design to compare different forms of maintenance support. Additionally, detailed evaluation of overweight adolescent behaviours over at least 12 months will be necessary to understand the type of behaviour change that may be achievable during the maintenance period.
Chapter 9.0 Conclusion

This thesis described the diet and attitudes of overweight and obese adolescents before, during and after participating in Curtin University’s Activity, Food and Attitudes Program.

The objectives of this thesis were:

1) To investigate the perceptions of adolescents, parents and stakeholders regarding barriers and facilitators to recruitment, retention and maintenance associated with a healthy lifestyle program

2) To examine the patterns of dietary intake for obese adolescents entering a healthy lifestyle program

3) To provide a detailed description of the development of the dietary component of CAFAP

4) To assess adolescent dietary change for food groups, energy intake, nutrients, eating behaviours and adherence from post-intervention to 12 months post-intervention.

5) To evaluate the experiences of adolescents receiving text messaging support during the maintenance period

The five studies in this thesis aimed to address the major gaps identified in in Chapter Two. The findings from these studies have built on the existing evidence and the implications for research and practice have been discussed in Chapter Eight. These findings and implications have contributed substantially to the evidence base and will be integral to inform future research and intervention design for overweight adolescents. A summary of the recommendations for future research and practice are included below.
9.1 Summary of recommendations for research and practice

1) Strategies to enhance recruitment and retention need to be tailored to the local community and be integrated with existing services.

2) Robust dietary assessment methods are needed to understand the details of overweight adolescent diet.

3) Tailoring of dietary messages to reflect overweight adolescent consumption patterns may be useful to include in targeted, evidence-based dietary interventions.

4) The choice of dietary intervention for overweight adolescents should be justified and the intervention reported in rich detail. It is recommended that a small number of practical topics are included and sessions are delivered in a hands-on way.

5) Overweight adolescent diet reporting ought to include a comprehensive summary of energy intake, food group intake, nutrient intake and eating behaviours. This should be assessed for at least 12 months following intervention.

6) Reporting of adherence to the dietary intervention principles of future interventions is critical to understand how dietary interventions contribute to dietary change.

7) There is a strong need to account for the impact of underreporting on overweight adolescent dietary data to develop accurate estimates of intake.

8) It is recommended that research during the maintenance period employs a strong study design to accurately assess the impact of the maintenance program.

9) Support processes offered during the maintenance period need to include opportunities for adolescents to provide feedback about their experiences. Researchers and health professionals need to be able to respond to this feedback in a timely way.
10) Text messaging during the maintenance period may not be appropriate in overweight adolescents. Future research is needed to understand if it can be used effectively to support behaviour change.

9.2 Final conclusions

This thesis contributes novel evidence to the existing literature by describing the development and evaluation of an evidence-based, dietary intervention for overweight adolescents, and examining how this impacts diet over an extended period of time. The comprehensive nature of the dietary reporting is a strength of this thesis and sets an example for future research. Further, the investigation of ways to support behaviour change demonstrates the importance of developing innovative methods of supporting adolescents to make long-term dietary change to improve their health and happiness.
Chapter 10.0 References


4364.0.55.003 Australian Health Survey 2011-2012. ABS, Canberra.

Australian Bureau of Statistics (2012c) Foods and nutrients. 4364.0.55.007 
Australian Health Survey 2011-2012. ABS, Canberra.

Australian Curriculum Assessment and Reporting Authority (2012) The Shape of the 

Bacon L. & Aphramor L. (2011) Weight science: evaluating the evidence for a 

F.A. Davis Company, Philadelphia.

Ball G.D., Mackenzie-Rife K.A., Newton M.S., Alloway C.A., Slack J.M., Plotnikoff R.C., 
& Goran M.I. (2011) One-on-one lifestyle coaching for managing adolescent 
obesity: Findings from a pilot, randomized controlled trial in a real-world, 

Ball G.D.C., Garcia A.P., Chanoine J.P., Morrison K.M., Legault L., Sharma A.M., 
families’ decisions regarding initiating, continuing, and terminating health 
services for managing pediatric obesity: the protocol for a multi-center, 
qualitative study. BMC Health Serv Res 12.

Longitudinal changes in the accuracy of reported energy intake in girls 10-15 
y of age. Am J Clin Nutr 78, 480-484.

energy intake in obese and nonobese adolescents. Am J Clin Nutr 52, 421- 
425.

high-calorie, low-nutrient-dense food consumption among obese and non-


Braude L. & Stevenson R.J. Watching television while eating increases energy intake. Examining the mechanisms in female participants. *Appetite* 76, 9-16.


Centre for Physical Activity and Nutrition Research (2012) Identifying effective strategies to increase recruitment and retention in community-based health promotion programs. Deakin University, Melbourne.


Department of Health and Ageing & National Health and Medical Research Council (2011) *A review of the evidence to address targeted questions to inform the revision of the Australian Dietary Guidelines*. NHMRC, Canberra.


Marques M., Moleres A., Rendo-Urteaga T., Gomez-Martinez S., Zapatera B.,
Romero P., de Miguel-Etayo P., Campoy C., Martinez J.A., Azcona-San Julian
nutritional therapy for overweight and obese Spanish adolescents
conducted by registered dieticians; the EVASYON study. *Nutricion

improving school achievement in overweight or obese children and

Martin K., Rosenberg M., Miller M., French S., McCormack G., Bull F., Giles-Corti B.
nutrition and body size in Western Australian children and adolescents: the Child and Adolescent Physical Activity and Nutrition Survey (CAPANS).*
Western Australian Government, Perth.

Mauriello L.M., Ciavatta M.M.H., Paiva A.L., Sherman K.J., Castle P.H., Johnson J.L. &
Prochaska J.M. (2010) Results of a multi-media multiple behavior obesity

McClain A.D., Hsu Y.W., Belcher B.R., Nguyen-Rodriguez S., Weigensberg M. &
Spruijt-Metz D. (2011) Physical inactivity, but not sedentary behavior or
energy intake, is associated with higher fat mass in Latina and African


McManus A., Smith K., Kerr D., Newton W., McManus J., Storey J., White J., Cuesta-

Dietary assessment methods among school-aged children: Validity and


National Health and Medical Research Council (2013a) *Australian Dietary Guidelines.* National Health and Medical Research Council, Canberra.

National Health and Medical Research Council (2013b) *Clinical practice guidelines for the management of overweight and obesity in adults, adolescents and children in Australia.* National Health and Medical Research Council, Melbourne.

National Health and Medical Research Council (2013c) *Educator Guide.* National Health and Medical Research Council, Canberra.


Shrewsbury V., Chou A., Steinbeck K., Nguyen B., Baur L., Lee A., O’Connor J., Kohn
additional therapeutic contact for overweight management via short

Shrewsbury V., O’Connor J., Steinbeck K., Stevenson K., Lee A., Hill A., Kohn M., Shah
community-based healthy lifestyle program for overweight and obese

Kohn M., Torvaldsen S. & Baur L.A. (2011a) Short-term outcomes of
community-based adolescent weight management: The Loozit(R) Study.

parents in pre-adolescent and adolescent overweight and obesity treatment:

prevention of excessive weight gain by discouraging students from drinking


Tracking of childhood overweight into adulthood: a systematic review of the

Singh R., Martin B.R., Hickey Y., Teegarden D., Campbell W.W., Craig B.A., Schoeller
measured metabolizable energy intake with total energy expenditure in


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Appendix A

CAFAP ethics approval
Memorandum

To: Professor Leon Straker, School of Physiotherapy
From: A/Professor Stephan Millett, Chair, Human Research Ethics Committee
Subject: Protocol Approval HR 30/2011
Date: 18 April 2011

Thank you for providing the additional information for the project titled "Enhancing activity, nutrition and mental health in overweight adolescents: Stage 1". The information you have provided has satisfactorily addressed the queries raised by the Committee. Your application is now approved:

- You have ethics clearance to undertake the research as stated in your proposal.
- The approval number for your project is HR 30/2011. Please quote this number in any future correspondence.
- Approval of this project is for a period of twelve months 12-04-2011 to 12-04-2012. To renew this approval a completed Form B (attached) must be submitted before the expiry date 12-04-2012.
- If you are a Higher Degree by Research student, data collection must not begin before your Application for Candidacy is approved by your Faculty Graduate Studies Committee.
- The following standard statement must be included in the information sheet to participants:
  This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number HR 30/2011). The Committee is comprised of members of the public, academics, lawyers, doctors and pastoral carers. Its main role is to protect participants. If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/- Office of Research and Development, Curtin University, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784 or by emailing hrec@curtin.edu.au.

Applicants should note the following:

It is the policy of the HREC to conduct random audits on a percentage of approved projects. These audits may be conducted at any time after the project starts. In cases where the HREC considers that there may be a risk of adverse events, or where participants may be especially vulnerable, the HREC may request the chief investigator to provide an outcomes report, including information on follow-up of participants.

The attached FORM B should be completed and returned to the Secretary, HREC, C/- Office of Research & Development:
When the project has finished, or
- If at any time during the twelve months changes/amendments occur, or
- If a serious or unexpected adverse event occurs, or
- 14 days prior to the expiry date if renewal is required.
- An application for renewal may be made with a Form B three years running, after which a new application form (Form A), providing comprehensive details, must be submitted.

Regards,

A/Professor Stephan Millett
Chair Human Research Ethics Committee
Thank you for your application submitted to the Human Research Ethics Committee (HREC) for the project titled "Enhancing activity, nutrition and mental health in overweight adolescents: Stage 2". Your application has been reviewed by the HREC and is approved.

- You have ethics clearance to undertake the research as stated in your proposal.
- The approval number for your project is HR 105/2011. Please quote this number in any future correspondence.
- Approval of this project is for a period of twelve months 06-09-2011 to 06-09-2012. To renew this approval a completed Form B (attached) must be submitted before the expiry date 06-09-2012.
- If you are a Higher Degree by Research student, data collection must not begin before your Application for Candidacy is approved by your Faculty Graduate Studies Committee.
- The following standard statement must be included in the information sheet to participants:

  This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number HR 105/2011). The Committee is comprised of members of the public, academics, lawyers, doctors and pastoral carers. Its main role is to protect participants. If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/- Office of Research and Development, Curtin University, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784 or by emailing hrec@curtin.edu.au.

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- If at any time during the twelve months changes/amendments occur, or
- If a serious or unexpected adverse event occurs, or
- 14 days prior to the expiry date if renewal is required.
- An application for renewal may be made with a Form B three years running, after which a new application form (Form A), providing comprehensive details, must be submitted.

Yours sincerely,

[Signature]

Associate Professor Stephan Millett
Chair Human Research Ethics Committee
Appendix B
CAFAP Stage One
parent/adolescent consent/assent form
Title: Enhancing activity, nutrition and mental health in overweight adolescents: Stage 1

Name of Investigators: Professor Leon Straker, Associate Professor Alexandra McManus, Associate Professor Deborah Kerr, Dr Angela Fielding, Dr Melissa Davis, Emily Ward, Kyla Smith, Dr Anne Smith, Dr Rebecca Abbott, Professor Tim Olds and Professor Tony Wright

General Purpose, Methods and Demands:
Around a quarter of Australian teenagers are overweight, which increases their risk of poor physical and mental health. Effective programs are urgently needed to help overweight teenagers develop and maintain healthy activity, food and attitude habits.

Curtin University has developed a special program for overweight teenagers and their families. The aim of this project is to gain information from overweight teenagers and their families on how to make this program as easy, effective and the results as long lasting as possible.

Adolescents who are overweight and aged 12-16 years, and their parents/carers, will be invited to participate in a focus group to obtain their opinions about Curtin’s healthy lifestyle program. A focus group helps researchers to find out what people think about certain products or services. A trained facilitator will run the focus group by asking a series of questions to help group members discuss their thoughts, perceptions and opinions. During our focus groups we will ask a series of questions to help teenagers and parents/carers discuss what they think may work well and what could be improved for the healthy lifestyle program.

You have been invited to attend a focus group with 8-10 people at a convenient location.

- Separate groups will be run for adolescents and parents/carers.
- The discussion will take 1 hour of your time.
- The person leading the focus group will make an audio-tape recording of the discussion but your name will not be attached to any comments. During the discussion, you may use a name other than your own if you wish.
- We will also ask you to fill out a short questionnaire detailing age and school level details. Your name will not be recorded on this sheet.
- We will give you a gift voucher for $20 at the end of the discussion, in recognition of your time and effort.

Risks, Discomforts and Benefits:
You will only participate if your parent/you are satisfied you understand what is expected of you and the risks, discomforts and benefits of the study.
The main risk to you is the discomfort of thinking and talking about why you/your child is overweight. This may be the main benefit to you/your family also, as it may help you to develop healthier habits.

Your input will help us develop a better program and so help other teenagers and their families develop better habits and so live happier, healthier lives.

**Confidentiality:**
All information provided by you will be confidential and no personal identifying details will be collected. Your identity will not be disclosed in any published material resulting from the study.

**Request for more information:**
You/your parent are encouraged to discuss any concerns you have regarding the study with study staff at any time. If you would like, we can send you a copy of the summary of the study when we have analysed all the discussions.

**Consent to Participate:**
If you decide to participate in this study after considering this information, please understand your participation is voluntary and you have the right to withdraw your consent or discontinue participation at any time without discrimination, judgment or penalty.

**Further Information:**
If you have any further queries, please don’t hesitate to contact Professor Leon Straker on 92663634 or l.straker@curtin.edu.au

This study has been approved by the Curtin University Human Research Ethics Committee (Approval number HR30/2011). The committee is comprised of members of the public, academics, lawyers, doctors and pastoral carers. Its main role is to protect participants. If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/- Office of Research and Development, Curtin University, GPO Box U1987, Perth WA 6845 or by telephoning 9266 2784 or by emailing hrec@curtin.edu.au

Thank you very much for your involvement in this research, your participation is greatly appreciated and will help improve the health of Australian teenagers.
Participant Consent Form – Parent/Carer

Title: Enhancing activity, nutrition and mental health in overweight adolescents: Stage 1

Name of Investigators: Professor Leon Straker, Associate Professor Alexandra McManus, Associate Professor Deborah Kerr, Dr Angela Fielding, Dr Melissa Davis, Emily Ward, Kyla Smith, Dr Anne Smith, Dr Rebecca Abbott, Professor Tim Olds and Professor Tony Wright

I have read the Participant Information Sheet. Any questions I have asked have been answered to my satisfaction. I agree to participate in this research but understand that I can change my mind or stop at any time. I understand that all information provided is treated as confidential. I agree that research gathered for this study may be published provided names or any other information that may identify me is not used.

- I understand the purpose and procedures of the focus group.
- I have been provided with the participant information sheet.
- I understand that the focus group itself may not benefit me.
- I agree for this focus group to be tape recorded.
- I understand that my involvement is voluntary and I can withdraw at any time without prejudice.
- I understand that all information will be securely stored for 5 years before being destroyed.
- I have been given the opportunity to ask questions.
- I agree to participate in the study outlined to me.

Participant ___________________________ Date ____________

Investigator __________________________ Date ____________
Participant Consent Form – Adolescent

Title: Enhancing activity, nutrition and mental health in overweight adolescents: Stage 1

Name of Investigators: Professor Leon Straker, Associate Professor Alexandra McManus, Associate Professor Deborah Kerr, Dr Angela Fielding, Dr Melissa Davis, Emily Ward, Kyla Smith, Dr Anne Smith, Dr Rebecca Abbott, Professor Tim Olds and Professor Tony Wright

I have read the information Participant Information Sheet. Any questions I have asked have been answered to my satisfaction. I agree to allow my child to participate/to participate in this research but understand that my child/I can change my mind and stop at any time. I understand that all information provided is treated as confidential. I agree that research gathered for this study may be published, provided names or any other information that may identify my child/me is not used.

- I understand the purpose and procedures of the focus group.
- I have been provided with the participant information sheet.
- I understand that the focus group itself may not benefit me.
- I agree for this focus group to be tape recorded.
- I understand that my involvement is voluntary and I can withdraw at any time without prejudice.
- I understand that all information will be securely stored for 5 years before being destroyed.
- I have been given the opportunity to ask questions.
- Parent – I consent to my child participating.
- Teenager – I assent to participate in the study outlined.

Parent/guardian ___________________________ Date ____________

Participant (teenager) ___________________________ Date ____________

Investigator ___________________________ Date ____________
Appendix C

CAFAP Stage One stakeholder consent form
**Title:** Enhancing activity, nutrition and mental health in overweight adolescents: Stage 1

**Name of Investigators:** Professor Leon Straker, Associate Professor Alexandra McManus, Associate Professor Deborah Kerr, Dr Angela Fielding, Dr Melissa Davis, Emily Ward, Kyla Smith, Dr Anne Smith, Dr Rebecca Abbott, Professor Tim Olds and Professor Tony Wright

**General Purpose, Methods and Demands:**

Around a quarter of Australian teenagers are overweight, which increases their risk of poor physical and mental health. Effective programs are urgently needed to help overweight teenagers develop and maintain healthy activity, food and attitude habits.

Curtin University has developed a special program for overweight teenagers and their families. The aim of this project is to gain information from key stakeholders involved in the provision of services to overweight/obese adolescents and their families on how to make this program as easy, effective and as long lasting as possible.

You have been invited to participate in an in-depth interview to offer your opinions about healthy lifestyle programs and their implementation in metropolitan and rural Western Australia. The interview will take 1 to 1 ½ hours of your time. The interviewer will make an audio-tape recording of the discussion but your name will not be attached to any comments. During the discussion, you may use a name other than your own if you wish. You will also be asked to complete a short questionnaire regarding your organisation’s role. We would like to offer you a gift voucher for $50 in recognition of your time and effort.

**Confidentiality:**

All information provided by you will be confidential. Your consent form and any communication material identifying you will be stored separately to the tape recordings. Your identity will not be disclosed in any published material resulting from the study.

**Request for more information:**

You are encouraged to discuss any concerns you have regarding the study with study staff at any time. If you would like, we can send you a copy of the summary of the study when we have analysed all the interviews.

**Consent to Participate:**
If you decide to participate in this study after considering this information, please understand your participation is voluntary and you have the right to withdraw your consent or discontinue participation at any time without discrimination, judgment or penalty. If you withdraw, your data will be destroyed.

**Further Information:**

This research proposal has been approved by the Curtin University Human Research Ethics Committee.

If you request any further information, or have any queries you wish to be answered, please don't hesitate to contact Professor Leon Straker on 92663634 or l.straker@curtin.edu.au

Please direct any ethical complaints to the Human Research Ethics Committee (Secretary) on phone: 9266 2784 or hrec@curtin.edu.au or in writing C/- Office of Research and Development, Curtin University, GPO Box U1987, Perth WA 6845.

Thank you very much for your involvement in this research; your participation is greatly appreciated and will improve services aimed at helping Australian adolescents to be healthier.
**Title:** Enhancing activity, nutrition and mental health in overweight adolescents

**Name of Investigators:** Professor Leon Straker, Associate Professor Alexandra McManus, Associate Professor Deborah Kerr, Dr Angela Fielding, Dr Melissa Davis, Emily Ward, Kyla Smith, Dr Anne Smith, Dr Rebecca Abbott, Professor Tim Olds and Professor Tony Wright

I have read the Participant Information Sheet. Any questions I have asked have been answered to my satisfaction. I agree to participate in this research but understand that I can change my mind and stop at any time. I understand that all information provided is treated as confidential. I agree that research gathered for this study may be published provided names or any other information that may identify me is not used.

- I understand the purpose and procedures of the study.
- I have been provided with the participant information sheet.
- I understand that the procedure itself may not benefit me.
- I agree for this interview to be tape recorded.
- I understand that my involvement is voluntary and I can withdraw at any time without prejudice.
- I understand that all information will be securely stored for 5 years before being destroyed.
- I have been given the opportunity to ask questions.
- I agree to participate in the study outlined to me.

________________________________________________________________________

Participant __________________________ Date ___________

________________________________________________________________________

Investigator __________________________ Date ___________
Appendix D

CAFAP past participant focus group prompts
Past participants (parents and adolescents) - Focus group discussion prompts

Black dot points are the main prompts, white dot points are follow up prompts.

Finding out about and getting interested in the program

- What was it that made you enquire about CAFAP in the first place?
  - Was there anything that almost stopped you from enquiring?

Staying with the program

- What made it difficult to stay engaged in the program?
  - When filling out the forms, it was sometimes difficult for parents and kids to do these, or remember to bring them back. How can we make this process easier?
  - Would assessments be better done in the home or at the clinic/Curtin?
  - We have noticed that some families have had issues with:
    - Distance/transport
    - Time
    - Length of program
    - Other after school commitments
    - Lack of interest
  - How can we deal with these?
  - ADOLESCENT SPECIFIC
    - How can we keep the motivation up in the gym? Would a buddy system work?
    - Was it important for you to have people in the group who were the same age/gender as you?
- What were the benefits of staying with the program?
- When completing ‘at-home’ activities, it was sometimes difficult for parents and kids to remember to do these. How could we make this easier?
  - Would you like a reminder? (SMS, phone, email, electronic media?)

Keeping up with the changes

- What did you change as a result of the last program? Why?
  - What stopped you from making other changes?
  - Is there too much or not enough information in the program? Would we better to focus on a couple of main ideas and refresh this several times?
  - How well do you think the professionals from physiotherapy, dietetics, psychology and social work actually worked together to make the program fit together and make sense?
  - Do you have any suggestions for how the key messages or activities delivered by the different professionals (physiotherapist, dietician, psychologist and social worker) could have fitted together better?
  - Do you refer to the goals you set during the program? If not, how can we make goal setting more useful for your family?
- Sometimes it can be difficult to get families back for testing at 3 and 6 months. How can we make this easier, or how can we provide incentive?
• What kind of ongoing support would have been helpful after you had completed CAFAP?
  o Would you like to be contacted by SMS, phone, email, electronic media?
  o Are there any services in your community that we can help you get/stay involved in?
Appendix E

CAFAP potential participant focus group prompts
Focus group discussion prompts

Black dot points are the main prompts, white dot points are follow up prompts.

Parents:

Finding out about and getting interested in the program

• What would get you interested in a program like CAFAP?
  o Who would you ask or where would you look for information about a program like CAFAP?
  o Here is a sample of our advertising flyer. What interests you? How would you immediately know that this program may be good for you and your family?
  o What would be the most important things for CAFAP to do to help adolescents take some interest/be willing to find out more about the program?

• What would prevent you from being involved in a program like CAFAP?
  o What would put you off enquiring about a program like CAFAP?
  o What would put you off being involved in CAFAP?

• Why would you like to be involved in a program like CAFAP?
  o What are the key concerns you have about your child’s health/weight?
  o What behaviours concern you? *(may indicate ways to target parents’ main concerns)*
  o What would you expect to get from a program like this?
  o CAFAP is not a weight loss program. Our program focuses on healthy lifestyle changes rather than weight loss. With a healthy diet, regular exercise and healthy attitudes, we find that body weight will respond and stabilise on its own accord. If this is different to your expectations, how could we explain this best or sell this idea to you?
  o From the flyer, what do you understand to be the role of parents in the CAFAP program? Our program includes parents in all sessions and their active participation is integral to creating healthier lifestyles for adolescents. How can we ensure that from the beginning, parents have a clear understanding about their important role in the program?

Staying with the program

• What are the general barriers to being and staying involved in a program like CAFAP? How could we overcome these?
  o We have noticed that some families have had issues with:
    ▪ Distance/transport
    ▪ Time
    ▪ Length of program
    ▪ Other after school commitments
    ▪ Lack of interest from child
  o How can we deal with these?
  o How close to your home/school would the program need to be?
This program includes parents in every session (2 hours, twice a week for 8 weeks). How can we encourage parent involvement/make this more inviting for parents?

This program includes an hour of testing/data collection before the program, after the program and at 3 months after the program. Would assessments be better done in the home or at the clinic/Curtin?

We ask adolescents and parents to complete a number of forms before and after the program to provide information about any changes in their behaviours and feelings, to help us evaluate the effectiveness of the program. Sometimes parents and kids find it difficult to do these, or remember to bring them back. How can we make this process easier?

- What would you identify as positive aspects of this program that may interest other parents? (may indicate ways to target parents’ main motivators)

Keeping up with the changes

- What kind of ongoing support do you think would be helpful once your family had completed a program like CAFAP?
  - Would you like to be contacted by SMS, phone, email, electronic media?
  - Are there any services in your community that we can help you get/stay involved in?

Adolescents:

Finding out about and getting interested in the program

- What would get you interested in a program like CAFAP?
  - Who would you ask or where would you look for information about a program like CAFAP?
  - Here is a sample of our advertising flyer. What interests you? How would you immediately know that this program may be good for you?

- What would put you off being involved in a program like CAFAP?
  - What would put you off telling your family about a program like CAFAP?

- Why would you like to be involved in a program like CAFAP?
  - CAFAP is not a weight loss program. Our program focuses on healthy lifestyle changes rather than weight loss. With a healthy diet, regular exercise and healthy attitudes, we find that body weight will respond and stabilise on its own accord. If this is different to your expectations, how could we explain this best or sell this idea to you?

Staying with the program

- What are the general barriers to being involved in a program like CAFAP? How could we overcome these?
  - We have noticed that some adolescents have had issues with:
    - Not knowing other teenagers in the group
    - Time (after school)
• Length of program
• Other after school commitments
• Lack of interest

How can we deal with these to encourage you to join in?

○ Would you need to know if there are other participants in the group who are the same age and/or gender as you?
○ We need to have a number of forms filled in before and after the program. Sometimes parents and kids find it difficult to do these, or remember to bring them back. How can we make this process easier?

• What would you identify as positive aspects of this program? (may indicate ways to target adolescents’ main motivators)

Keeping up with the changes

• What kind of ongoing support do you think would be helpful once your family had completed a program like CAFAP?
  ○ Would you like to be contacted by SMS, phone, email, electronic media?
  ○ Are there any services in your community that we can help you get/stay involved in?
Appendix F

CAFAP stakeholder interview schedules
Stakeholders: Interview prompts

Health professionals (including community health nurses, GPs, allied health workers)

Practice and management

- Do you currently see overweight/obese teenagers in your practice?
- How many or how regularly would you see overweight/obese teenagers?
  - For what proportion would overweight/obesity be the primary presenting complaint?
  - Would you consider mentioning the teen’s weight if it wasn’t their primary complaint?
  - For those teenagers you do see for overweight/obesity, how do you manage them?
- What guides your service delivery?

Community services

- What are the strengths of services offered?
- What are the current gaps in services for overweight teenagers and their families?
- Ideally, what kind of services would you like to be available to overweight/obese teens?
- What facilities are around that may be used to deliver a lifestyle program to overweight teens? (CAFAP needs a meeting room, exercise equipment area and basic food preparation facilities)
- What are the costs associated with using such facilities?
- Are you involved in or aware of health-related groups that run successfully in the community (not necessarily for adolescents)? What can we learn from them?

Recruitment

- What do you think are the main issues in getting people interested and enrolled in a program?
  - What works for you?
  - How did you try to overcome any barriers?
  - If you knew that CAFAP existed, what kind of information would you want to know about it?
  - Here is a sample of our advertising flyer. How would you immediately know that this program may be good for families you see? What other information would you need?
  - Who is well-placed to refer or recruit teenagers?
  - How do we best get our referral information to you? Or other referrers?
  - How would you mention this program to families? Would you feel comfortable talking about this?
  - What could we provide (for health professionals or families) to make this discussion easier?
  - What level of feedback would you like about participants you have referred?
Retention

- What do you think are the main issues in keeping individuals/families engaged in health services?
  - Did you have any difficulties keeping individuals/families involved in your practice?
    - Why do people dis-engage?
    - How did you try to overcome these barriers?
  - Do you have any suggestions about using goal setting to help keep individuals/families engaged?
  - What do you think individuals/families respond well to that keeps them engaged?

Maintenance

- What do you think are the main issues in helping individuals/families maintain positive healthy lifestyle changes after a program?
  - What support services can we link participants with once they have completed the program?
    - How do you know about these services or how do others find out about them?
  - Have you got any ideas or comments about sustaining positive healthy lifestyle changes?
  - Are there other people that may have valuable insight into this area that you think we should speak to?

Program

- If CAFAP was to be implemented in your local area, is this something that you or your organisation would support? What support would you be able to provide?
- Would you be interested in being involved in the implementation of this program in your local community?
  - What interests you and what puts you off?
  - What else should our team consider?

Researchers

- Could you briefly outline your experience researching issues related to obesity intervention programs for adolescents
  - Intervention studies – age group, nature of program
  - Other research – reviews, assessment method development...

- What do you think are the main issues in getting families interested and enrolled in a program?
  - Did you have difficulties recruiting overweight/obese teenagers?
    - How did you try to overcome these?
  - We have recruited families through advertisements in the Parent’s Paper and community newspaper, local radio ads and inclusion of information in school newsletters. We have also written to GPs and Allied Health professionals in the area and asked them to refer appropriate clients. How can we improve our strategy?
o  We aim to target overweight and moderately obese adolescents (have previously mainly recruited severely obese). What different issues may this raise?

- What do you think are the main issues in keeping families engaging in a program?
  o  Did you have any difficulties keeping families involved in your program?
    - How did you try to overcome these?
  o  This is a timetable summary of our current program. I can explain/ give you some more detail about program content if needed. Do you have any suggestions for improvement to help engagement?
  o  This is a list of the assessments we have previously included before and after the program. Do you have any suggestions for reducing the burden and improving the utility?
  o  Do you have any suggestions about using goal setting to help keep families engaged?

- What do you think are the main issues in helping families maintain positive healthy lifestyle changes after a program?
  o  How have you helped overweight teens to maintain their healthy changes once they finished your program?
  o  We are considering using IT (SMS/Email/Facebook) to encourage maintenance. Do you have any comments or ideas about how to do this well?
  o  Do you have any suggestions about integrating participants into community run physical activity?
  o  Any other suggestions to help maintain lifestyle changes?

**Council:**

- What services are currently available for overweight teenagers in this local area?
- What are the strengths of services offered?
- What are the limitations of services offered?
- Who is involved in offering services?
- Who is well-placed to refer or recruit teenagers?
- What facilities are around that may be used to deliver a lifestyle program to overweight teens? (CAFAP needs a meeting room, exercise equipment area and basic food preparation facilities)
- What are the costs associated with using such facilities?
- If CAFAP was to be implemented in your local area, is this something that your organisation would support? What support would you be able to provide?
- What support services can we link participants with once they have completed the program?
  o  How do you know about these services or how do others find out about them?
- Are there other people that may have valuable insight into this area that you think we should speak to?

**Policy makers:**
• Do you know of any current services available for overweight/obese teenagers?
  o Who organises these services?
• Ideally, what kind of services do you think needs to be available for overweight/obese teens?
• We hope to implement CAFAP in two metropolitan communities later this year. Is there anything that we need to know about the way health services are currently delivered? (eg/ clinical pathways, service priorities, health professional limitations)
• Would your organisation/service have any capacity to be involved in:
  o Recruitment/referral of overweight teenagers
  o Delivery of CAFAP
  o Maintenance programs/support
• Would your organisation be happy to endorse or support the implementation of CAFAP?
• How can we best work with you in the future?
Appendix GG

CAFAP Australian New Zealand Clinical Trials Registry details
Registry details
Among overweight adolescents, does a community based program (Curtin Activity, Food and Attitudes Program) lead to improved activity and food behaviours?

**UTN**

**Secondary ID [1]**

**None**

**Trial acronym**

**CAFAP2**

**Health condition(s) or problem(s) studied:**

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<tr>
<td>Diet and nutrition</td>
<td>Obesity</td>
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**Descriptions of intervention(s) / exposure**

Intensive 8 week period involving twice weekly sessions of 2 hours duration followed by 12 weeks of maintenance contact.

On entry into the study participants will be assessed and be placed on a waitlist for 8-12 weeks before being assessed again prior to starting the intensive 8 week program. This waitlist period will provide a within-subject control period. Participants will be assessed at the end of the 8 week intensive program and again after 3, 6 and 12 months. Cohorts of 10-15 adolescents (along with a parent for each) will be recruited in 2-3 geographical regions with multiple cohorts in each region. The staggered start to the multiple cohorts in each region provides a control over major external events.

The intensive program involves 1 hour of exercise and 1 hour education and support twice weekly for adolescents. Exercises include aerobic, strength, power and endurance stations and are performed in a group setting administered by a physiotherapist. Education and support covers activity, food and attitudes. Activity intervention includes education to improve moderate/vigorous physical activity, light activity and sedentary behaviours. Food intervention includes education to improve healthy eating behaviours. Attitude intervention includes goal setting, problem solving, affect regulation. Education sessions are administered in a group setting by one of the physiotherapy, nutrition, social work or psychology facilitators.

The intensive program includes 2 hours of education and support for parents of the adolescents. Some sessions are combined with adolescents. Other sessions include ‘walk and talk’ informal support, supermarket buying skills, snack and meal preparation skills, providing autonomy support for adolescents.

The 2 hour twice weekly adolescent and parent sessions during the intensive phase occur concurrently, with some joint education sessions.

The 3 month maintenance program includes several reminders and review of goal setting each week using information technologies (phone, SMS, email, web) and occasional group meetings.
Primary Outcome: Physical activity assessed by accelerometer (time in sedentary, light and moderate/vigorous activity)
Timepoint: study entry (pre waitlist), pre program (post waitlist), immediately post program, 3, 6 and 12 months post program

Primary Outcome: Nutrition behaviour assessed by 3 day food diary (daily serves of fruit, vegetables, ‘extras’)
Timepoint: study entry (pre waitlist), pre program (post waitlist), immediately post program, 3, 6 and 12 months post program

Secondary Outcome: Sedentary behaviours assessed by questionnaire
Timepoint: study entry (pre waitlist), pre program (post waitlist), immediately post program, 3, 6 and 12 months post program

Secondary Outcome: Nutrition behaviours assessed by questionnaire
Timepoint: study entry (pre waitlist), pre program (post waitlist), immediately post program, 3, 6 and 12 months post program

Secondary Outcome: Physical status assessed by examination (BMI, waist and hip girth, cardiovascular fitness (modified shuttle walk test), muscle strength (quadriceps, biceps, deltoid manual break test), muscle power (vertical jump), muscle endurance (abdominal curls))
Timepoint: study entry (pre waitlist), pre program (post waitlist), immediately post program, 3, 6 and 12 months post program

Secondary Outcome: Mental health assessed by Moods and Feelings questionnaire
Timepoint: study entry (pre waitlist), pre program (post waitlist), immediately post program, 3, 6 and 12 months post program

Secondary Outcome: Quality of life assessed by Paediatric Quality of Life - Teen Report
Timepoint: study entry (pre waitlist), pre program (post waitlist), immediately post program, 3, 6 and 12 months post program

Secondary Outcome: Autonomy support, structure and involvement (Perceived Autonomy Support Scales for Exercise Settings and Perceived Environmental Supportiveness Scale) and autonomous motivation (Revised Behavioural Regulations and Exercise Scale, Integrated Regulation Scale for Exercise Behaviour, and Perceived Locus of Causality for Dieting) for physical activity and healthy eating
Timepoint: study entry (pre waitlist), pre program (post waitlist), immediately post program, 3, 6 and 12 months post program

Secondary Outcome: Parental mental health assessed by Depression Anxiety and Stress Scale
Timepoint: study entry (pre waitlist), pre program (post waitlist), immediately post program, 3, 6 and 12 months post program

Secondary Outcome: Family functioning assessed by McMaster Family Assessment Device general functioning subscale
Timepoint: study entry (pre waitlist), pre program (post waitlist), immediately post program, 3, 6 and 12 months post program

Secondary Outcome: Goal attainment and conflict assess by questionnaire
Timepoint: goal conflict will be assessed at study entry (pre waitlist), pre program (post waitlist), immediately post program, 3, 6 and 12 months post program

gain attainment will be collected each week during the intervention period (starting from middle of the intensive intervention period when goal setting is introduced) and at followups

Secondary Outcome: Program evaluation using interviews with participants and facilitators
Timepoint: immediately post program and 12 months post program

Key inclusion criteria: body mass index > 85th percentile
Minimum age: 11 Years
Maximum age: 16 Years
Gender: Both males and females
Healthy volunteers? No
Key exclusion criteria: obesity due to identified genetic, metabolic, endocrine disease; psychiatric disorder; medic assessed as unsuitable to participate

Study type: Interventional
Purpose of the study: Prevention
Allocation to intervention: Nonrandomised trial
Describe the procedure for enrolling a subject and allocating the treatment (allocation concealment procedures)

Describe the methods used to generate the sequence in which subjects will be randomised (sequence generation)

Masking / blinding
Who is / are masked / blinded (choose all that apply)
Open (masking not used)

Assignment
Other
Other design features
multiple cohort, staggered start, waitlist controlled, within subject design
Type of endpoint (s)
Efficacy

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Phase

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Recruitment in Australia

Recruitment state(s)

Recruitment outside Australia

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Address:
| PO Box 1284 |
| West Perth WA 6872 |

Country: Australia

Primary Sponsor
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Address:
| GPO Box U1987 |
| Perth WA 6845 |

Country: Australia

Secondary Sponsor:
| Name: | None |

Address:

Country:

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Has the study received approval from at least one Ethics Committee?
Yes

Ethics Committee name:
Curtin University Human Research Ethics Committee
**Brief summary**

This study aims to help overweight adolescents develop healthy activity, food and attitude habits. Adolescents and their parents participate in an intensive 8 week program (involving twice weekly 2 hour sessions) followed by regular contact for 3 months to assist with goal achievement. The study hypothesis is that adolescent activity and food behaviours will be improved after the intensive program and be maintained at 12 months post program.

**Trial website**

cafap.curtin.edu.au
Appendix H

Table showing compliance with TREND checklist for transparent reporting of nonrandomized evaluations of behavioural and public health interventions
See Straker et al. (2014) for the reporting of this data

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<td>Inclusion of aspects employed to help minimize potential bias induced due to non-randomization (e.g., matching)</td>
<td>y 5</td>
</tr>
<tr>
<td>Topic</td>
<td>Page</td>
<td>Description</td>
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<td>-------------------------------</td>
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</tr>
<tr>
<td>Blinding (masking)</td>
<td>9</td>
<td>Whether or not participants, those administering the interventions, and those assessing the outcomes were blinded to study condition assignment; if so, statement regarding how the blinding was accomplished and how it was assessed.</td>
<td>y 8</td>
</tr>
<tr>
<td>Unit of Analysis</td>
<td>10</td>
<td>Description of the smallest unit that is being analyzed to assess intervention.</td>
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<tr>
<td></td>
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<td>If the unit of analysis differs from the unit of assignment, the analytical method used to account for this (e.g., adjusting the standard</td>
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<tr>
<td>Statistical Methods</td>
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<td>Statistical methods used to compare study groups for primary methods outcome(s), Statistical methods used for additional analyses, such as a subgroup analyses and Methods for imputing missing data, if used</td>
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<td></td>
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<td>Statistical software or programs used</td>
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<td>Results</td>
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<td>Participant flow</td>
<td>12</td>
<td>Flow of participants through each stage of the study: enrollment, assignment, allocation, and intervention exposure, follow-up, analysis (a)</td>
<td>y</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Enrollment: the numbers of participants screened for eligibility, found to be eligible or not eligible, declined to be</td>
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<tr>
<td></td>
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<td>o Assignment: the numbers of participants assigned to a study</td>
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<td>o Allocation and intervention exposure: the number of participants assigned to each study condition and the number of</td>
<td>y</td>
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<td>o Follow-up: the number of participants who completed the follow-up or did not complete the follow-up (i.e., lost to</td>
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<td>o Analysis: the number of participants included in or excluded from the main</td>
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<td>Description of protocol deviations from study as planned, along with reasons</td>
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<td>Recruitment</td>
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<td>Dates defining the periods of recruitment and</td>
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<tr>
<td>Baseline Data</td>
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<td>Baseline demographic and clinical characteristics of participants in each study Baseline characteristics for each study condition relevant to specific disease Baseline comparisons of those lost to follow-up and those retained, overall and by study condition</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Comparison between study population at baseline and target population of interest</td>
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<tr>
<td>Baseline equivalence</td>
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<td>Data on study group equivalence at baseline and statistical methods used to control for baseline differences</td>
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<tr>
<td>Category</td>
<td>Code</td>
<td>Description</td>
<td>Requirement</td>
</tr>
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<td>--------------------------------</td>
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</tr>
<tr>
<td>Numbers analyzed</td>
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<td>Number of participants (denominator) included in each analysis for each study condition, particularly when the denominators change for different conditions.</td>
<td>y</td>
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<tr>
<td>Outcomes and estimation</td>
<td>17</td>
<td>For each primary and secondary outcome, a summary of results for each estimation study condition, and the estimated effect size and a measure of precision.</td>
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<td></td>
<td></td>
<td>Inclusion of null and negative findings</td>
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<tr>
<td></td>
<td></td>
<td>Inclusion of results from testing pre-specified causal pathways through which the intervention was intended to work.</td>
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<tr>
<td>Ancillary analyses</td>
<td>18</td>
<td>Summary of other analyses performed, including subgroup or restricted analyses, indicating which results were included or excluded.</td>
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<tr>
<td>Adverse events</td>
<td>19</td>
<td>Summary of all important adverse events or unintended effects in each study condition (including summary measures, effect size).</td>
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</table>

**DISCUSSION**

<table>
<thead>
<tr>
<th>Category</th>
<th>Code</th>
<th>Description</th>
<th>Requirement</th>
<th>Score</th>
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</thead>
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<tr>
<td>Interpretation</td>
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<td>Interpretation of the results, taking into account study hypotheses, sources of potential bias, imprecision of measures.</td>
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<td>11-14</td>
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<td></td>
<td></td>
<td>Discussion of results taking into account the mechanism by which the intervention was intended to work (causal pathways) or effect modification.</td>
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<td>13-14</td>
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<td></td>
<td></td>
<td>Discussion of the success of and barriers to implementing the intervention, fidelity of implementation.</td>
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<td></td>
<td></td>
<td>Discussion of research, programmatic, or policy aspects.</td>
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<td>Generalizability</td>
<td>21</td>
<td>Generalizability (external validity) of the trial findings, taking into account the study population, the characteristics of the intervention, length of follow-up, incentives, compliance rates, specific settings.</td>
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<tr>
<td>Overall Evidence</td>
<td>22</td>
<td>General interpretation of the results in the context of current evidence and current theory.</td>
<td>y</td>
<td>11-14</td>
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</table>


For more information, visit: [http://www.cdc.gov/trendstatement/](http://www.cdc.gov/trendstatement/)
Appendix I

CAFAP Stage Two parent/adolescent consent/assent form
**Title:** Enhancing activity, nutrition and mental health in overweight adolescents: Stage 2

**Name of Investigators:** Professor Leon Straker, Professor Alexandra McManus, Associate Professor Deborah Kerr, Dr Angela Fielding, Dr Melissa Davis, Dr Emily Ward, Kyla Smith, Ashley Fenner, Dr Anne Smith and Professor Tim Olds

**General Purpose, Methods and Demands:**

Around a quarter of Australian teenagers are overweight, which increases their risk of poor physical and mental health. Effective programs are urgently needed to help overweight teenagers develop and maintain healthy activity, food and attitude habits.

Curtin University has developed a special program for overweight teenagers and their families. The results from this initial program have reinforced the importance of including activity, food and attitudes components, to help overweight and obese adolescents manage their weight. In Stage 1 of this project, the research team worked with overweight teenagers and their families to find out how to make this program as easy, effective and the results as long lasting, as possible. The program has since been refined and we are now aiming to test whether delivering such a program in local communities can make it more accessible and effective.

Adolescents who are overweight and aged 12-16 years, and their parents/carers, will be invited to participate in this study for about 15 months. (In the description to follow 'you' refers to the adolescent participating in the study.) We will ask you to participate in an 8 week program, meeting twice a week for 2 hours duration each time. On each visit you will do exercise for about 1 hour and in the other hour participate in group sessions focussing on your activity, food and attitudes and your skills related to these. You will be in a group with other adolescents. Your parent will also need to attend at the same time— they will not do the exercises with you but will participate in discussion about the same topics and also gain some related skills. We will take sound and video recordings of several sessions to help us check how the program is going. Only the CAFAP team will have access to these recordings.

Three months before you start the program we will measure your activity habits, fitness, food habits and attitudes. We will measure these again just before the program starts, at the end of the program and 3, 6 and 12 months after the program.

To measure your activity we will ask you some questions in a questionnaire and ask you to wear an activity monitor (looks like a watch) on a strap around your waist for a week. To measure your heart and lung fitness we will ask you to run up and down a 10 metre track. To measure your strength we will ask you to bend your knee, bend...
your elbow and raise your arm while we measure how much force you can push with. To measure your leg muscle power we will ask you to jump as high as you can. To measure your body we will measure your height, weight and waist circumference. To measure your food habits we will ask you to keep a diary of everything you eat and drink for 3 days and fill in a short questionnaire. To measure your attitudes we will ask you to fill in some questions about your feelings. All this measurement will take about 2 hours each time. If you answer the questions at home in your own time, the measurements will take less than an hour. We will also ask your parent/guardian to complete some of their own forms.

Risks, Discomforts and Benefits:

You will only participate if you and your parent are satisfied that you both understand the purpose of the research, what is expected of you and the risks, discomforts and benefits of the study. You and your parent will be asked to sign a form declaring you are willing to participate. You should not feel discomfort at any point in this research.

There are a number of potential risks you need to understand. You may injure yourself doing the exercises, or doing other physical activity at home. We will teach you how to exercise properly so you have very little risk of injury. Having your body measured can be a bit embarrassing. We will measure you on your own, not in a group, to minimise this. Thinking and talking about how you feel can be upsetting. We will provide support to you in the group and can arrange individual discussions with you. If assessments or group participation identify a physical or mental health problem we will discuss this with you and your parent to provide information about appropriate support.

Participation in this study will have direct benefits for you. The assessments will give you a clear picture of what your current activity, food and attitude habits are. The discussions will give you a good understanding of how to change these habits to improve your health and happiness. The exercise skills and other skills you learn will be useful to you for the rest of life. Applying the skills and knowledge will lead to improved health for you and a lower risk of health problems.

There will also be benefits to others. Once we have tested this program and possibly refined it based on your feedback, we will try to make the program available to other adolescents across Western Australia. We will also present what we have learned about the program at scientific conferences and publish the results in scientific journals. This will help others provide successful programs for overweight adolescents across Australia and the world.

Confidentiality:

All information provided by you will be confidential. Your identity will not be disclosed in any published material resulting from the study, unless you have given separate consent for public use of any images.

Request for more information:

You and your parents are encouraged to discuss any concerns you have regarding the study with study staff at any time. If you would like, we can send you a copy of
the summary of the study when we have analysed all the results.

**Consent to Participate:**

If you decide to participate in this study after considering this information, please understand your participation is voluntary and you have the right to withdraw your consent or discontinue participation at any time without discrimination, judgment or penalty.

**Further Information:**

If you have any further queries, please don't hesitate to contact Professor Leon Straker on 92663634 or l.straker@curtin.edu.au

This study has been approved by the Curtin University Human Research Ethics Committee (Approval number HR105/2011). The committee is comprised of members of the public, academics, lawyers, doctors and pastoral carers. Its main role is to protect participants. If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/-Office of Research and Development, Curtin University, GPO Box U1987, Perth WA 6845 or by telephoning 9266 2784 or by emailing hrec@curtin.edu.au

Thank you very much for your involvement in this research, your participation is greatly appreciated and will help improve the health of Australian teenagers.
**Title:** Enhancing activity, nutrition and mental health in overweight adolescents: Stage 2

**Name of Investigators:** Professor Leon Straker, Professor Alexandra McManus, Associate Professor Deborah Kerr, Dr Angela Fielding, Dr Melissa Davis, Dr Emily Ward, Kyla Smith, Ashley Fenner, Dr Anne Smith and Professor Tim Olds

I have read the information on the Participant Information Sheet. Any questions I have asked have been answered to my satisfaction. I agree to allow my child to participate/to participate in this research but understand that my child and I can change my mind and stop at any time. I understand that all information provided is treated as confidential. I agree that research gathered for this study may be published, provided names or any other information that may identify my child/me is not used.

- I understand the purpose and procedures of the study.
- I have been provided with the participant information sheet.
- I understand that my involvement is voluntary and I can withdraw at any time without prejudice.
- I understand that no personal identifying information like my name and address will be used and that all information will be securely stored for 7 years before being destroyed.
- I have been given the opportunity to ask questions.
- Parent – I consent to my child participating and to participating myself in the study outlined to me.
- Teenager – I assent to participate in the study outlined to me.

________________________________________ ____________  
Parent/guardian      Date  

________________________________________ ____________  
Participant (teenager)     Date  

________________________________________ ____________  
Investigator       Date
Appendix J

CAFAP medical practitioner consent form
Dear Doctor,

Curtin University’s Activity, Food and Attitudes Program is a multidisciplinary intervention for overweight adolescents. The 8 week program involves adolescents attending twice weekly for 2 hour sessions. Each session involves about an hour of exercise in a gym and an hour of education and support. Parents will also attend education and support sessions. Activity components are delivered by physiotherapists. Food components are delivered by dietitians. Attitude components are delivered by psychologists and social workers. The most strenuous activities would be cycling on an exercise bike at a ‘hard’ intensity for 7 – 10 minutes and bench pressing weights with supervision (maximum weight 20kg). Adolescents and families will receive 12 months follow up after completing the program.

Participant Profile
The program is designed for 12-16 year old adolescents with a BMI for age >85th centile: who can attend regularly with a parent, who can safely participate in exercise, whose overweight status is unlikely to be due to genetic, endocrine or metabolic disease and who can appropriately participate in adolescent group sessions.

Participation
If you believe the program is suitable for an individual and you can confirm that there are no physical or psychological reasons why they should not participate in such a regimen and that their overweight status is not secondary to a treatable medical or metabolic condition then please provide their details below and send this form to the address below. A CAFAP team member will then contact the parent/carer.

Date: ____________________________

Adolescent’s name: ____________________________

Adolescent’s DOB: ____________________________

Address: ______________________________________

____________________________________________________________________

Parent’s name: __________________________________________
Parent’s phone number: ________________________________

☐ Please confirm that this referral has been discussed with the parent/carer (tick the box).

Doctor’s Name: __________________________ Signature: __________________________

Please send recommendation to: Kyla Smith, CAFAP Program Coordinator
Email: cafap@curtin.edu.au
Fax: 9266 3699
Post: School of Physiotherapy, Curtin University, PO Box U1987, Perth, 6845
Appendix K

Example CAFAP timetable
<table>
<thead>
<tr>
<th>Week</th>
<th>Session#</th>
<th>Adolescents</th>
<th>Parents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td><strong>Introduction to program – overview of program, introductions, group rules, key messages: be more active, be less inactive, eat more fruit and vegetables, eat less junk food, set goals</strong></td>
<td><strong>Introduction to program – joint session</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Introduction to Activity sessions – types of activity, benefits, how to assess moderate intensity, warm up, circuit, cool down</strong></td>
<td><strong>Expectations – Parent discussion of their expectations of the program</strong></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td><strong>Activity session – adding stations, review heart rate</strong></td>
<td><strong>Walk and talk (parents and facilitators go for a walk together to model being more active) – topics – get to know each other</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Healthy eating – energy balance, basic nutrition principles: variety and nutrients.</strong></td>
<td><strong>Healthy eating - joint session</strong></td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td><strong>Activity session – adding new circuit stations</strong></td>
<td><strong>Understanding adolescence – teens need choice, competence, belonging Parents can provide structure, be involved, support teenager choices</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Healthy activity – be more active, be less inactive, benefits of being active, activity and inactivity, energy out balance</strong></td>
<td><strong>Health activity - joint session</strong></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td><strong>Activity session – adding stations</strong></td>
<td><strong>Providing structure – Setting up house rules, monitoring behaviour and observance of rules, consequences for breaking rules.</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Portion size – portion size guidelines, food group intake, eat more fruit and vegetables, eat less junk food</strong></td>
<td><strong>Portion size - joint session</strong></td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td><strong>Activity session – increasing speed</strong></td>
<td>Parent introduction to goal setting – setting goals to support teenager goals.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Teens introduction to goal setting – how to set goals, feedback on current activity and eating behaviours (using pre-intervention assessment information), start to set goals</strong></td>
<td>Walk and talk – topics – get to know each other, how it’s going, review house rules</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td><strong>Activity session – increasing speed (30 mins only)</strong></td>
<td><strong>Fast food and dinner- fast food (takeaway) and parent planning for ‘fast’ dinners at home (4:30-5:30pm)</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Teens setting goals (1.5 hours) 1st half- teens use feedback to set own goals. 2nd half- parents join to listen to teen goals</strong></td>
<td><strong>Parents setting goals to support teens (last ½ hour only- with teens) Parents set goals to support teen goals</strong></td>
</tr>
<tr>
<td>Time</td>
<td>Activity</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>4:30-5:30pm</td>
<td>Activity session (30 mins only)</td>
<td>Review and debrief of progress – supporting teenager activity and food goals and competence</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PEGoals - (30 mins) - teens reflect on goal progress, write new weekly goals (20 mins) and share with parents (10 mins)</td>
<td>Goals - (20 mins) - 10 mins to review weekly progress then join with teens for 10 mins</td>
<td></td>
</tr>
<tr>
<td>5:30-6:30pm</td>
<td>Family activity – review of key activity messages, benefits of activity, identification of positive and less positive activity, inactivity &amp; sleep habits of family, opportunities for goals</td>
<td>Family activity – joint session</td>
<td></td>
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<tr>
<td>4:30-5:30pm</td>
<td>Activity session</td>
<td>Walk and talk – topics – parenting issues</td>
<td></td>
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<tr>
<td>5:30-6:30pm</td>
<td>Family food – review of key food messages, identification of positive and less positive food habits of family members, encourage positive eating behaviours to use in goal setting</td>
<td>Family Food – joint session</td>
<td></td>
</tr>
<tr>
<td>4:30-5:30pm</td>
<td>Activity session – (30 mins)</td>
<td>Parent-teen relationships – parenting styles to provide structure, be involved, support teenager choices, maintaining good relationships.</td>
<td></td>
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<tr>
<td></td>
<td>PEGoals - (30 mins) - teens reflect on goal progress, write new weekly goals (20 mins) and share with parents (10 mins)</td>
<td>Goals - (15 mins) - 5 mins to review weekly progress then join with teens for 10 mins</td>
<td></td>
</tr>
<tr>
<td>5:30-6:30pm</td>
<td>Overcoming barriers to achieve goals – things that help, influence of mood</td>
<td>Overcoming barriers to achieve goals – joint session</td>
<td></td>
</tr>
<tr>
<td>4:30-5:30pm</td>
<td>Activity session 45 minutes then teens complete checklist and knowledge and skills mastery check</td>
<td>Walk and talk</td>
<td></td>
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<tr>
<td>5:30-6:30pm</td>
<td>Snacks - problem solving, snacks that help you eat more fruit and vegetables and eat less junk food</td>
<td>Snacks – joint session</td>
<td></td>
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<tr>
<td>4:30-5:30pm</td>
<td>Activity session - 30 minutes</td>
<td>Food budgeting – money spent on food groups, planning to get more good food for your money</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PEGoals - (30 mins) - teens reflect on goal progress, write new weekly goals (20 mins) and share with parents (10 mins)</td>
<td>Goals - (15 mins) - 5 mins to review weekly progress then join with teens for 10 mins</td>
<td></td>
</tr>
<tr>
<td>5:30-6:30pm</td>
<td>Food labelling – understanding labels, sugar in drinks, eat less junk</td>
<td>Food labelling – joint session</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Number</td>
<td>Activity Session</td>
<td>Community Opportunity</td>
</tr>
<tr>
<td>-------------</td>
<td>--------</td>
<td>------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>4:30-5:30pm</td>
<td>12</td>
<td>PE</td>
<td>Community opportunity – ideas for healthy activity and good food in your community using family findings from resource homework</td>
</tr>
<tr>
<td>5:30-6:30pm</td>
<td></td>
<td>9:30</td>
<td>Togetherness – creative reflection on program involvement using paint colours to symbolise what participants have gained</td>
</tr>
<tr>
<td>4:30-5:30pm</td>
<td>13</td>
<td>PE</td>
<td>Supermarket visit – nutrition and cost of foods, reviewing food labelling skills and budgeting skills</td>
</tr>
<tr>
<td>5:30-6:30pm</td>
<td></td>
<td>8</td>
<td>Teen problem solving to achieve goals (35 mins) - dealing with setbacks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>Goals – (25 mins) - teens reflect on goal progress, write new weekly goals (15 mins) and share with parents (10 mins)</td>
</tr>
<tr>
<td>4:30-5:30pm</td>
<td>14</td>
<td>PE</td>
<td>Parents in the kitchen - cooking healthy snacks with fruits and vegetables</td>
</tr>
<tr>
<td>5:30-6:30pm</td>
<td></td>
<td>8</td>
<td>Teens in the kitchen - cooking healthy snacks with fruits and vegetables</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>Parent problem solving to achieve goals - dealing with setbacks</td>
</tr>
<tr>
<td>4:30-5:30pm</td>
<td>15</td>
<td>PE</td>
<td>Recipe ideas – modifying recipes to be tasty and healthy, feedback on program to date</td>
</tr>
<tr>
<td>5:30-6:30pm</td>
<td></td>
<td>8</td>
<td>3 month goal setting. Long term goals. (15 mins just teens)</td>
</tr>
<tr>
<td>4:30-5:30pm</td>
<td>16</td>
<td>PE</td>
<td>Cooking Celebration Preparation - prepare celebration food, confirm follow up arrangements</td>
</tr>
<tr>
<td>5:30-6:30pm</td>
<td></td>
<td>8</td>
<td>Cooking Celebration – joint session</td>
</tr>
</tbody>
</table>

Session facilitated by: All, physiotherapist/exercise physiologist (PE), dietitian (D) or psychologist (P)

Shading indicates adolescent and parent joint sessions
Appendix L

CAFAP dietary intervention
background summaries for
dietitian facilitators
Key concepts – Nutrition: Energy In

- Energy balance: need to balance energy in (kJ eaten) with energy out (energy used in living and exercise)
- Adolescents need variety in their diet
- Macronutrients contribute differing amounts of kilojoules
- More fruit and vegetables, less “extra” foods

The 2007 Children’s Nutrition and Physical Activity Survey found that approximately 25% of boys and 30% of girls aged 9-13 years were classified as overweight or obese [1]. Of teenagers aged 14-16 years, 25% of boys and 23% of girls were also classified as overweight or obese.

It has been suggested that changes to environmental and societal factors such as a decrease in physical activity, an increase in sedentary behaviour and the availability of high fat, high energy food have contributed to the high rates of overweight and obesity [2, 3]. An intake of foods high in fat and high in energy has the potential to lead to passive overconsumption which can contribute to the energy imbalance that precedes weight gain [4, 5]. These foods are often termed ‘extra’ foods or ‘junk’ foods given their high energy density but low nutrient density [6, 7]. A low intake of nutrient dense, low energy foods like fruits and vegetables is also thought to be a key contributor to the development of overweight and obesity [8]. The data around teen intakes of fruits, vegetables and junk foods is alarming, with 76.4% of girls and 71.9% of boys not meeting the guidelines for vegetable intake and 77.8% of teenage boys and 71.7% of girls not meeting the guidelines for fruit intake [9]. Conversely, 99.8% of teens consumed extra foods every day and on average extra foods contributed 42.7% of daily energy intake [6].

When working with overweight and obese teenagers, the concept of energy balance is vitally important to understand- that is what is consumed (kJ from food) must be balanced with what is expended (energy for living and exercising) [5, 10-12]. Creating energy balance (for weight maintenance) or negative energy balance (for weight loss) is the most important concept for this session. Adolescents and parents can often find it difficult to understand the concept of energy balance but it is an important component of broader obesity interventions [13]. It is recognised that knowledge does not lead to change in dietary behaviours, particularly in adolescents, but energy balance knowledge provides a foundation for some of the upcoming CAFAP sessions. The current literature suggests that 23% of 15 year old boys and 6% of 15 year old girls in Australia are consuming more than the upper bound of the estimated energy requirements for their age [1], making energy balance almost impossible. The goals that are made around energy balance should be decided upon after considering the child’s age, rate of growth and development, extent of overweight and presence of co-morbidities [12].

As in the first session, it is important to acknowledge that adolescents may be working ‘against’ a genetic component that favours weight gain. There are recognised modifiers of energy balance that necessitate individuals to reduce their energy intake and increase their energy output significantly more than others to achieve negative (or even neutral) energy balance. For overweight adolescents it
may be that they have inherited a genetic profile, that when combined with an environment that also favours weight gain, leads to the development of overweight and eventually obesity [14, 15]. This concept of an “obesogenic environment” refers to conditions where energy dense food is readily available and physical activity is easily avoidable [16, 17]. Some factors that make it harder to achieve energy balance within such an environment include a low relative resting metabolic rate (RMR), presence of insulin resistance, a high relative respiratory quotient (volume of CO2 produced for oxygen used), a low relative leptin (appetite related hormone) concentration and a limited capacity for fat oxidation [15, 18, 19]. Other factors out of the control of individual’s relate to birth weight, maternal smoking habits, the effect of intrauterine diabetes and ethnic background [19, 20]. Some ethnic groups, particularly indigenous groups, have been shown to have genetic profiles that favour weight gain- perhaps stemming from an evolutionary need to survive in times of famine [15, 20]. In one further complication, a deliberate reduction in energy intake can be counteracted by a reduction in energy expenditure as the body strives to prevent weight change, making it somewhat harder to lose weight [18]. The important idea to take from all of this is that if these factors do exist; they exist within a complex system, within a complex environment. This may mean that individuals are more susceptible to weight gain, but does not mean that they cannot change their behaviour within their environment to counteract this.

The nutrition component of the program focuses on reducing total energy intake by reducing the intake of fats and sugars (extras/non-core foods) and increasing the intake of fruits and vegetables [21-25]. The program does not focus on kilojoule intake, nor is there a focus on specific nutrients. The concept of food groups and associated recommendations are discussed in the next session. In this session we do discuss the concepts of energy density relating to macronutrients and the importance of variety within the diet, however, these are only used to give context to the “energy in, energy out” message. Adolescents tend to have a poor understanding of energy density and this may contribute to uninformed nutrition choices now and later in life [13]. It is recommended that education about energy density forms a small part of a more holistic and broad intervention [13]. It is also recognised that the concept of energy density has limitations [26] and is not the sole influence on energy consumption.

Background about macronutrients and adolescent dietary requirements

Adolescence is a period of rapid maturation, therefore a balanced intake of macronutrients (carbohydrate, protein and fat) and micronutrients (vitamins and minerals) is important to support cognitive, physical and social growth and development [27]. The energy content of the different macronutrients is discussed to highlight that fat has more than double the kilojoule content of protein or carbohydrate when compared gram to gram [5].

Of particular importance during adolescence is sufficient intake of key nutrients like iron, zinc, calcium, vitamin C and fibre. Generally, a balanced intake of all food groups provides sufficient nutrients for growth and development. However, only 34.6 % of Australian teenagers reported eating at least one food from each of the 5 food groups every day [28]. Measures of variety are useful indicators of dietary
patterns and quality, and tools that generate a variety ‘score’ can be used to provide feedback to individuals [29]. This is useful to raise awareness of the consequences of limited variety, particularly for adolescents and/or parents who may be classified as pre-contemplative or contemplative in the Stages of Change model [30, 31]. Inadequate dietary intake and therefore insufficient intake of nutrients can interfere with biochemical pathways, which relates to poor growth, health, cognition and behaviour outcomes [32, 33]. It is also recognised that dietary patterns of adolescents track into adulthood, indicating that promotion of healthy eating behaviours during this time is of high importance for long-term health [32].

Summary

In summary, this “energy in” session starts to introduce the basic healthy lifestyle principles that are essential in managing and treating overweight and obesity in children [11]. We consider energy balance, the role of different macronutrients and the importance of variety.

In the next few nutrition sessions we will consider recommendations from each of the food groups, the concept of controlling portion size and balancing the energy contributions of different foods and give participants some feedback about their intake of fruits, vegetables and junk foods. Energy balance will be discussed again next week, and this concept will come up again in most of the nutrition sessions. The physiotherapist will build on the “energy out” side of the equation next week.

References

10. Wilson, A.M., A.M. Magarey, and N. Mastersson, Reliability and relative
validity of a child nutrition questionnaire to simultaneously assess dietary patterns associated with positive energy balance and food behaviours, attitudes, knowledge and environments associated with healthy eating. International Journal of Behavioral Nutrition and Physical Activity, 2008. 5: p. -.


29. Worsley, A., et al., The relationship between education and food


Key concepts: Healthy eating

- Adolescents aren’t eating enough fruit and vegetables and are eating excessive amounts of junk food
- The Australian Guide to Healthy Eating provides recommendations for consumption from the different food groups
- Portion size is a significant contributor to total energy intake
- Changes in specific eating patterns including meal frequency, consumption of food away from home, portion sizes and dietary quality may be related to increasing rates of overweight and obesity in adolescents
- Portion size education at breakfast and lunch is incredibly important for overweight adolescents
- Breakfast provides a significant opportunity for consumption of key nutrients
- Lunch provides an opportunity for consumption of fruit and vegetables
- Self-monitoring is a good way of maintaining healthy change

Adolescent diet

Adolescence is characterised by increasing independence, and is often a time where teenagers begin to make their own lifestyle choices and start to be influenced more by friends and media [32, 34]. It appears that in this shift towards adulthood, adolescents tend to make poor dietary choices. Recent surveys of Australian and Western Australian adolescents suggest that diet quality in this group is compromised by low intakes of fruits and vegetables and high intakes of extra foods [1, 9]. ‘Extras’ are defined as foods not from core food groups, often providing high levels of fat, sugar and salt [6, 7, 35]. In 2008, 37.3% of Western Australian adolescents consumed no fruit on the day of the study and 21.9% failed to consume any vegetables [9]. In 2004-05, 89.8% of adolescents were consuming extra foods on a daily basis [28]. National data from 2007 indicated that only 22% of children aged 14-16 consumed less than the recommended intake of saturated fat and only 39% were classified as consuming less than a moderate amount of sugar (<20% of energy provided by sugar) [1].

The Australian Guide to Health Eating (AGHE) and the Dietary Guidelines for Children and Adolescents in Australia (DG) are the two national publications used to guide the development of the nutrition component of CAFAP [35, 36]. *The AGHE is currently under review and some suggested changes have already been incorporated into the CAFAP recommendations. This session considers portion sizes, general intakes of macronutrients (as discussed last week), food group recommendations and self-monitoring.

It has been identified that adolescents generally have adequate knowledge of basic nutrition, but lack understanding of portion sizes and kilojoules (energy) [37]. This is often reflected in main meals where they may know the difference between healthy and unhealthy foods, but are unable to serve appropriate portions of each or recognise foods that contribute significant amounts of energy. There is plenty of
room for improvement in the current breakfast and lunch habits of Australian teenagers. This session looks at basic rules for portions at breakfast, lunch and dinner (with a focus on the earlier meals of the day, as dinner is covered in a previous session). The new American dietary education tool “My Plate” has recently been launched with one of the key messages being “Make Half Your Plate Fruits and Vegetables” [37] whilst Finnish school lunch guidelines suggest a balanced lunch is made up of half a plate of vegetables, a quarter of a plate of meat, chicken or fish and another quarter as potato, rice or pasta [38]. CAFAP guidelines echo these messages and use basic household items to illustrate appropriate portion sizes for breakfast and lunch.

Breakfast habits

Skipping breakfast has been discussed in more detail in the “Family Food Habits” session, and it is generally well established that adolescents who skip breakfast are more likely to be overweight [39], with some adolescent girls misguidedly avoiding breakfast as method of weight control. Skipping breakfast is related to a higher likelihood of making poor nutrition choices during the day [40] and has an immediate negative impact on concentration levels and capacity for learning and therefore school performance [32, 41]. Deshmukh-Tasker et al. [39] found that teenagers who skipped breakfast were also less likely to consume less fruits and vegetables and have a greater percentage of energy contributed by added sugars, whilst Rampersaud et al. [41] found that these adolescents were also less likely to participate in physical activity. Eating breakfast should be encouraged as a positive and healthful behaviour, given teenagers who consume breakfast have higher intakes of micronutrients, specifically calcium which is of particular importance for teenage girls [41, 42]. This may come from the milk that is commonly consumed with ready-to-eat cereals. WA data suggests that 90% of teenagers consumed cereal at least once in the past year, indicating cereal’s popularity as a breakfast choice [9]. Some ready-to-eat cereals offer higher levels of important nutrients such as vitamin A, vitamin E, vitamin C, folate, B 12, iron, calcium, phosphorous, magnesium, potassium and fibre [39, 41-43], however, some cereals contain significant amounts of sugar, sometimes up to 47% by weight [44]. These ready-to-eat cereals tend to be one of the most heavily advertised food products, with a recent survey identifying 10 ads of 37 as cereals with sugar contents between 33-47% sugar by weight. [44] This highlights the need to promote consumption of a healthy breakfast as opposed to consuming any breakfast. A healthy breakfast should include a variety of food groups that provide an assortment of nutrients, without providing excessive amounts of energy. This sort of breakfast needs to be easy to prepare [45] and eat (possibly on the run), particularly for those short on time in the mornings [41, 45]. Parent modelling is also an important strategy for promoting breakfast consumption with adolescents [45].

Higher energy, carb, protein and fat intakes (although lower %fat of total energy)

Lunch habits
There are many influences on food choices for lunch that teenagers make at school, including opportunities to purchase food at the canteen, the effect of peer modelling and obviously taste preferences. In WA, about half of secondary students purchase their lunch at the canteen once a week, with a further 19.8% of boys and 12% of girls purchasing their lunch from the canteen every day [9]. Current recommendations for healthy lunches include taking a packed lunch to school and limiting adolescent spending money [24], however, many parents report that this can be difficult to encourage. Of WA adolescents, 44.6% of boys and 35.2% of girls never or rarely help with preparing their own lunch [9], indicating a potential strategy to involve teenagers in making their own choices and improving the acceptability of a home-packed lunch. Adolescents may choose not to eat lunch at school for a variety of reasons including not liking the foods offered, adolescents not being hungry, unpleasant eating environment or the influence of friends who were not eating the same food [38]. It has been suggested that skipping meals may favour weight gain with a study of 2870 school students demonstrating a link between regular meals and attainment of a healthy body weight[46]. This may arise from a greater reliance on high energy snack foods in the absence of main meals or possibly a reduced energy output from a decreased thermic effect after irregular meals over a long period of time [46]. In terms of those who do eat lunch, the difference between eating a balanced or unhealthy lunch was reflected in regularity of meals, with those who eat a balanced lunch being more likely to eat regular meals on both school and weekend days [38]. Many studies suggest that healthy or balanced lunches are more likely to come from home [24, 47] and these children tend to have more nutritionally adequate intakes than those who obtain their lunch from elsewhere 14. Those who a balanced school lunch in Finland ate fruit and vegetables more often than those who didn’t eat a balanced lunch [38], whilst in California, those who didn’t bring lunch from home consumed 1.75 time more soft drink and 4.75 fewer servings of fruits and vegetables than an adolescent who brought their own lunch every day [47].

**Portion size**

Portion control is an important concept for overweight adolescents and parents. Increasing rates of overweight and obesity across the world have been reflected by substantial increases in food portion sizes [23, 48]. Although this has not been identified as a causal relationship, it is thought that larger portion sizes will contribute to greater energy intake, with the potential to contribute to positive energy balance [48-50]. Evidence suggests that as children age, they begin to pay less attention to internal cues of hunger and satiety, and are influenced to eat more when served larger portion sizes [21]. Alarmingly, this is contributing to “portion distortion,” where large portion sizes are perceived as normal amounts to eat in one sitting [48]. It is recommended that health professionals work with teenagers and families to help them understand appropriate portion sizes that include a range of healthy foods as outlined by Australian food selection guides [24, 35, 49].
Summary

This session focuses on the first two meals of the day, educating teenagers about the importance of a balanced meal, and giving them the tools to construct or modify their own breakfast and lunch. Although there remains a lack of specific evidence about the nutrient intake of overweight adolescents as compared to healthy weight adolescents, modifying main meals to reduce energy content and increase nutrient content can only be a healthy change. This session builds on the concept of energy intake and introduces the concepts of portion control to meet the CAFAP goal of reduced energy intake through increased intake of fruit and vegetables and reduced intake of junk food.

In the next few nutrition sessions we will give participants some feedback about their own intake of fruits, vegetables and junk foods and look at how that compares to the recommendations. In week 3, we introduce the concept of self-monitoring specific food intake and later in the program we look at self-monitoring a range of dietary behaviours. Self-monitoring will be a key theme throughout the next few sessions (and important for after the program).

References


Key concepts- Nutrition- Fast food

- Fast food is consumed regularly by WA adolescents
- Consumption of fast food increases intake of energy, fat and soft drink
- Higher frequencies of fast food consumption has been related to overweight
- Fast food portions tend to be larger than meals prepared at home
- There are many factors related to the consumption of fast food including the TV viewing, family values, time spent in the car, employment and adolescent perceived barriers to healthy eating
- Families find it difficult to prepare quick and easy meals

The definition of fast food is “food purchased in self-service or carry-out eating places without waiter service” [51] p.1823. Fast food is often characterised by convenience, perceived low cost and high relative levels of fat and energy. Of WA teenagers, 13.7% girls and 26.4% boys consume meals or snacks from a fast food chain once a week [9]. Boys were also more likely to regularly consume fast food than girls with 7.1% consuming such foods 2-4 times per week. Other research suggests that one in five Australian adolescents consume fast food on a daily basis [28]. Adolescents who consume fried food away from home are more likely to have greater energy intakes, which leads to weight gain over time [4]. There is also evidence from the USA that suggests adolescent girls who eat fast food more than twice a week are likely to have a greater BMI than those who do not [52].

Frequency of fast food consumption is positively related to total energy intake, percentage energy derived from fat, soft drink intake and TV viewing [51]. Teenagers who consume fast food more frequently tend to have a higher availability of unhealthy foods in the home; are less concerned about healthy eating and identify strong perceived barriers to healthy eating [51]. A higher frequency of fast food consumption is inversely related to calcium intake [51], fruit intake and vegetable intake [51, 53]. French et al. did not find that a higher frequency of fast food intake was related to overweight, which was expected given a higher intake of fat and energy. This may reflect a level of underreporting that is typical of overweight adolescents [34] or may suggest that frequency of fast food intake is more of a long term predictor of weight gain [51]. In a study of young women and weight gain, it was shown that a low consumption of fast food was associated with weight maintenance (rather than weight gain) and lower BMI scores [54].

Fast food tends to be energy-dense and consumed in large portions that people have begun to perceive as appropriate to eat in one sitting [48]. This often results in more total energy being consumed than if a meal was prepared at home [11, 23]. Increases in portion sizes of fast food meals and the adoption of ‘up-sizing’ policies reflects the increasing rates of overweight and obesity [23]. Although this has not been identified as a causal relationship, it is thought that larger portion sizes will contribute to greater energy intake, with the potential to contribute to positive energy balance. Evidence suggests that as children age, they begin to pay less attention to internal cues of hunger and satiety, and are influenced to eat more with larger portion sizes [21]. Large portions of high energy-foods, particularly those prepared away from the home, are thought to be linked to the increasing prevalence of overweight and obesity [23]. Fast food restaurants have been identified as
Fast food is a booming industry and the high amount of advertising, along with the lack of healthy advertising, normalises an unhealthy way of eating [7]. Students who are employed by fast food restaurants may consume fast food more frequently given their increased exposure [51]. Families who spend more time in the car each day are more likely to eat at fast food restaurants than those who spend less time in the car [55]. Fathers who model frequent consumption of fast food have a positive influence on the amount of fast food their children eat, and the father’s belief regarding the importance of family meals at home is directly related to reduced consumption of fast food in the family [55]. Perceived healthy eating barriers (and fast food enablers) for adolescents include poor taste and inconvenience of preparing fresh food [51]. These issues will be addressed in the upcoming CAFAP cooking sessions.

Families need quick and healthy meal options to serve at home and teenagers need to be educated about choosing healthy options when eating out [12, 56]. Most fast food restaurants now have a healthy options menu, and the offerings from this menu tend to provide less total energy and up to an extra serve of vegetables [57]. However, consumers are easily confused by different items and research suggests that only 3% of consumers are actually choosing from the healthier menu [57]. Choice provides a good summary of the differences in energy, fat and sodium of some popular fast food choices [58].

Parents consistently report not having enough time to prepare healthy meals and choose fast food for its convenience [59]. Women from lower socioeconomic regions often report work commitments as a barrier to finding time to prepare healthy meals [59]. Research around barriers to healthy eating has identified that families who plan ahead and use strategies to organise their purchasing and preparation of foods (e.g. lists or preparing meals at the beginning of a week) tend to have higher levels of healthy eating [60]. Strategies around sourcing and preparing quick, easy and healthful foods may be useful for families limited by time [59].

**Summary**

In summary, this “Fast food” session covers the facts about fast food and highlights the importance of being able to prepare quick and healthy meals at home. This relates back to the concept of “energy in” and the recommendations from each of the food groups. It also links to the family food habits session where we cover the importance of family meals.

In the next few nutrition sessions we will work on food preparation and cooking skills to help parents and children feel confident about preparing quick, easy and healthy snacks, as well as looking more at the impact of the media on food choices and the role of sweetened beverages in adolescent diets.

**References**

Key concepts - Nutrition - Budgeting

- Perceived cost and actual cost of foods can significantly influence maternal food purchasing behaviours
- Families with greater financial restrictions or low SES families often have reduced diet quality when compared to higher SES families
- Education and skill building around effective budgeting is important for making healthy food choices

Food choices made by individuals are influenced not only by personal factors (e.g. taste) but also by environmental and social factors (e.g. cost and family habits), as explained using the Social Ecological Theory [32, 61]. The household budget, cost of food, and even the individual’s perception of the cost of food, all play an important role in shaping food choices.

It has been well established that socioeconomic status has a significant impact on diet quality, with families from lower SES tertiles more likely to consume less fruits and vegetables, and to have lower intakes of key vitamins and minerals [62-65]. Western Australian data suggests that adolescent boys from lower SES tertiles had the highest rates of not consuming breakfast [9]. The fibre intake of WA girls was significantly less in those from lower SES tertiles and soft drink was consumed significantly more by lower SES adolescents when compared to adolescents from higher SES areas. Lower SES adolescents tend to consume less fruits and vegetables and more total fat, snacks and irregular meals, whilst having a lower frequency of family meals [66]. In terms of healthful behaviours, the regularity of fresh fruit consumption was significantly higher for adolescents in the highest SES tertile than in the lowest SES tertile [9]. Rosenkranz and Dzewaltowski [65] have developed a model of the home environment as it relates to obesity and have clearly shown how children from lower SES groups are lagging behind their higher SES counterparts in all the areas mentioned above, as well as having less healthful foods at home, having parents who encourage healthy eating less and eating fewer meals. These findings are reflected in the higher prevalence of overweight in adolescents from lower SES backgrounds [65, 67].

The impact of parent modelling and provision of certain foods helps to shape adolescent food habits, however, it is important to consider potential influences on parent choices. In focus groups, women from low SES backgrounds rated cost as the most influential factor on their grocery food choices [59]. Women from medium SES areas also indicated that cost was an important consideration but did not always affect their choices. Women from low SES areas indicated that healthy foods, particularly fruits and vegetables, were often more expensive than unhealthy foods (this may be a misconception, currently evidence around the difference in cost of healthy and unhealthy foods is inconclusive [59]). If women perceived the cost of fruit to be too much, then they were more likely to be low consumers of fruit [68]. This perceived environmental barrier is reflected by a poorer availability of fruit and vegetables in the homes of families from lower SES brackets [69]. Given that this is one of the strongest correlates with intake for adolescents [64, 67, 69], parent education is of high importance.

The cost of healthy foods has a big impact on family food choices and in some
cases the cheapest food per serve can actually be from the ‘extras’ group, however, this group also provides the lowest nutrient density and highest energy density per serve [70]. Without sufficient knowledge and skill, parents may misguidedly choose more unhealthy options in an attempt to save money. Inglis et al. [71] considered the purchasing behaviours of mothers from different SES backgrounds and found that women from lower SES background purchased a greater percentage of less healthy foods than their counterparts from higher SES areas. When given a 25% increase in their food budget, lower income women purchased more healthy foods but still included more unhealthy foods and less healthy foods than high SES women. It is reassuring to note that parental understanding of nutrition and healthy foods can help them to manage their food budget to include more nutritious foods. The average household in Australia spends more than half its food budget on ‘extra’ foods [72], indicating that cost is only one of the primary factors influencing food purchases, and education and skill building is still required to help women (or the family shopper) make healthy food choices.

The evidence around reduced diet quality in low SES families, coupled with higher rates of overweight, perceived higher cost of food and greater financial restrictions, indicates that this an important area for nutrition professionals to provide education and skills training to promote healthy eating [73]. One of the most important strategies is guided by the Health Belief Model, in helping parents to develop strategies to overcome potential barriers and improve their self-efficacy [67]. This may include education and training around purchasing seasonal fruits and vegetables, using effective food budgeting strategies and preparing inexpensive healthy meals including fruits and vegetables [59, 67, 71]. An example of this would be working with families to replace some meat (highest cost per serve) with some vegetables/lentils (highest nutrient density per serve) [70].

Food Cents is a program designed initially to improve the healthful dietary behaviours of low income families and is now widely available to “promote a healthy way of eating to people wanting to save money on their food budget” [72]. Healthful eating is not necessarily a more expensive way of eating and with education, families can manage their budget and improve their diets [74]. The budgeting component of FoodCents has been adapted and modified for use with parents of overweight teenagers in this program.

Summary

In summary, this “budgeting” session addresses the perceived and actual costs of healthy foods. We assess current food spending habits and consider allocating a food budget to save money and promote healthy food choices.

In the next few nutrition sessions we will look at healthy and inexpensive food choices for breakfast and lunch, put our new budgeting knowledge to use on the supermarket tour and prepare some healthy snacks in the kitchen.

References


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**Key concepts- Nutrition- Food labelling and sugary drinks**
• Understanding food labels can help adolescents and parents to make healthier food choices
• Sugar-sweetened beverages (including soft drink, cordial and energy drinks) contribute extra energy that may lead to weight gain
• The relationship between sweetened beverages and body weight is controversial and the evidence is still emerging. It does appear that for overweight adolescents, limiting sugar-sweetened beverages can be a useful weight management strategy.

**Food labelling**

Food labels on packaged food provide accurate and accessible nutrition information to consumers. Those who read food labels tend to have healthier diets and consume foods lower in fat and higher in fibre [75]. There is consistent observational evidence that identifies a relationship between label readers and healthier diets [75, 76]. However, adolescents and obese people have been identified as groups that rarely use food labels when making food choices [75].

Educating people about food label reading is an effective way of helping to create a supportive environment in which to make healthy food choices [77]. Most nutrition messages are somewhat abstract and difficult for ordinary consumers to quantify. For example- ‘Limit saturated fat and moderate total fat intake’ [36] assumes that a consumer is actually able to identify the total and saturated fat content of different foods, be aware of appropriate levels of intake and choose foods that minimise their intake of total and saturated fat [78]. For children and adolescents, this can be difficult to do [78]. Research from Australia and New Zealand confirms this and suggests that although many consumers claim to look at food labels, they are often confused by the information provided [77]. Nutrition health professionals need to help consumers to interpret important nutrition information quickly and with meaning. It is recognised that calculations and health claims (on the packaging, not the nutrition information panel) has the potential to confuse or mislead consumers [75]. Education about comparing total energy, fat, saturated fat and sugar content can empower teenagers and their parents to make good food choices [77].

Expert panels recommend that overweight and obesity interventions teach people to read food labels [11, 12, 24] and other child and adolescent obesity intervention programs have used food labelling to encourage families to increase their intake of fruits, vegetables, low fat dairy [25, 79, 80]. For teenagers and parents, having the opportunity to use food labels to make healthier choices may be more effective than just restricting high fat foods, that otherwise they may focus on or crave [22]. Making healthier choices also emphasises the CAFAP message of adopting small and sustainable lifestyle changes that over time, will at the least prevent further weight gain [81]. Food label reading is a skill that will help with effective self-monitoring for weight management [82] and has considerable reach in the community with educated consumers able to pass on their knowledge to family members and friends [75]. Within families, this helps to create an environment that supports healthy food choices [77].
Sweet drinks

The relationship between sugar-sweetened beverages (SSB) and body weight is difficult to define and controversy surrounds the research. SSBs include soft drink, cordial, sugar-sweetened fruit juice and energy drinks, but a definition is difficult given an ever-increasing market of SSBs [83]. There is plenty of observational evidence suggesting a direct association, however comprehensive RCT data is not available and the available data shows little, if any, effect of SSBs on weight status [84]. However, much of this experimental research has been funded by companies with a vested interest in the sales of soft drink and other beverages, potentially leading to bias in the results. Given that SSBs definitively contribute to a higher total energy intake, the lack of an association may suggest that the interventions to actually reduce the intake of sweetened beverages are not yet particularly effective, without necessarily proving the absence of a relationship between SSBs and body weight [84].

Observational data suggests that the extra energy provided by sweet beverages has been linked to weight gain, and many studies indicate that higher intakes of SSBs are linked to higher BMIs during childhood [85-89]. Children and adolescents who consume an average of 265mL of soft drink daily consume almost 835 kJ more total energy every day than those who drink no soft drink [88]. Alarminglly, in 2007, 73% of Australian adolescents aged 14-16 were consuming an average of 573g of sugar-sweetened beverages per day [28]; contributing more than an extra 1600kJ to their daily energy intake. The odds ratio of becoming obese among children increases 1·6 times for every additional glass of SSB they consume per day [86].

Interestingly, most teenagers to not recognise the energy or nutrient content of SSBs and tend to drink them for taste alone [90]. SSBs contribute to total energy intake but the sugar appears to have less of a satiating effect then when it is consumed as a solid [91]. For this reason, SSBs have the potential to provide significant total energy and sugar, without adolescent consumers even being aware. Using a teaspoon to measure out the sugar content of soft drinks is a useful way for teenagers to have a visual reference for the sugar content of the drinks they consume.

The consumption of SSBs also has the potential to displace other more nutritious foods and drinks like milk and fruit juice [83, 88]. Reduced intake of milk and subsequently calcium has potential serious long term effects on achieving peak bone mass to prevent osteoporosis later in life [92]. The latest data on Australian adolescents aged 14-16 suggests that 44% boys and 82% of girls did not consume sufficient amounts of calcium to meet estimated average requirements (EAR) [1], with dairy products potentially being displaced by SSBs.

Although more research is required, the current evidence suggests that reducing consumption of SSBs may be an effective strategy to assist with weight management [90]. An RCT based on an environmental intervention with a group of adolescents showed that a reduction in soft drink consumption was related to reduction in body weight, although this was dependent on baseline BMI [89]. This effect was greater in adolescents who consumed more soft drink at baseline and
although there was no meaningful effect for teenagers of a healthy weight, overweight teenagers lost significant amounts of weight [89]. Further research with teenagers is needed but this suggests that limiting the consumption of SSBs is a useful strategy for the prevention and treatment of overweight teenagers.

Summary

In summary, this “food labelling and sugary drinks” session focuses on two key strategies that may be useful for managing overweight and obesity in adolescence. We consider using food labels to make healthier food choices and give adolescents and parents a tool to sort through the confusion of food marketing. We also give teenagers a visual image of the sugar ‘hidden’ in sweetened beverages and consider how this may affect energy balance.

In the next few nutrition sessions we will consider the role of the media on food choices, evaluate more food labels in a supermarket tour and look at how to modify recipes from home, using information found on food labels.

References

Key concepts- Nutrition- Family Food Habits

- Food habits or eating behaviours are strongly linked to weight status
- Key eating behaviours for adolescent weight control include having a healthy breakfast, eating dinner with their family (away from the TV), consuming homemade food rather than fast food and limiting consumption of sweetened beverages.
- Parents play an important role with modelling healthy food habits

There is limited literature comparing the intake of overweight or obese adolescents with general adolescent diets, to indicate differences that may be linked to weight control. Under-reporting of intake by overweight teenagers makes it difficult to ascertain accurate food consumption data [34, 93]. Some data suggests that obese adolescents appear to consume less well-balanced diets with a higher proportion of low nutrient density, high energy density foods consumed. The literature does identify a number of eating behaviours that are clearly linked to weight control, although it is important to recognise that causal relationships have not been established. There is consistent evidence to support involving the whole family in making lifestyle changes around these behaviours [11, 14].

Breakfast

It is recognised that overweight adolescents are more likely to skip breakfast than their normal weight counterparts [39], with some adolescent girls misguided avoiding breakfast as method of weight control. In Western Australia, 28.5% boys and 38.5% girls at secondary school skipped breakfast on the day of the study [9]. Skipping breakfast is related to a higher likelihood of making poor nutrition choices during the day [40] and has an immediate negative impact on concentration levels and capacity for learning and therefore school performance [32]. It has been shown that adolescents who skip breakfast have a higher percentage of their energy intake coming from fat [42], potentially contributing to a greater total energy intake, as well as a lower daily intake of important nutrients such as vitamin A, vitamin E, vitamin C, folate, B 12, iron, calcium, phosphorous, magnesium, potassium and fibre [39]. Deshmukh-Tasker et al. [39] found that adolescents who skipped breakfast had greater BMI and waist circumference measures than those who consume breakfast regularly. These teenagers were also less likely to consume less fruits and vegetables and have a greater percentage of energy contributed by added sugars.

Fast food

Adolescents who consume fried food away from home are more likely to have greater energy intakes, which leads to weight gain over time [4]. There is also evidence from the USA that suggests adolescent girls who eat fast food more than twice a week are likely to have a greater BMI than those who do not [52]. Of secondary school students in WA, 13.7% girls and 26.4% boys consume meals or snacks from a fast food chain once a week [9]. A further 7.1% of boys consume fast food 2-4 times per week. Eating away from home, particularly at fast food restaurants, leads to consumption of larger portions and often a greater total energy intake [23]. The 1995 National Nutrition Survey showed that as they got older, adolescents were eating more food obtained out of the home, and that these foods
generally had a higher relative fat content. In a study of young women and weight gain, it was shown that a low consumption of fast food was associated with weight maintenance (rather than weight gain) and lower BMI scores [54].

Parent modelling

Parents who encourage healthy eating (and activity) have potential to help their adolescents make healthy choices around food and activity. Parent intake reflects child intake for most food groups [94] and parent modelling is an important point for intervention [49, 64]. The children of parents who model regular breakfast consumption have higher intakes of fruit and vegetables [49]. Parental intake of fruit, vegetables and soft drink are independent predictors of their teenage daughter’s consumption of such products [95]. Often parent encouragement for healthy eating can decrease during adolescent years, as parents may run out of ideas to promote good food choices [96]. By modelling healthy eating practices and making healthy food options available and accessible (e.g. cutting up vegetables or having a well-stocked fruit bowl) all parents can play an important role in encouraging healthy eating [64, 94]. Parents need to promote healthy lifestyles and steer away from encouraging their adolescent to diet, to avoid disordered eating behaviours that can be detrimental to their adolescent’s well-being [96].

Family meals

An adolescent’s family plays an important role in shaping adolescent food choices, as explained by the Social Cognitive Theory [95]. The evening family meal has the potential to improve overall diet quality and help teenagers maintain a healthy body weight. Dinner provides the most energy and key nutrients than any other meal or snack in an adolescent’s diet and provides an opportunity for parents to model healthy eating behaviours and provide access to fruits and vegetables [32] [49] [25]. Eating at the table, and away from the TV is also an important recommendation for families who want to improve the quality of their diet [24]. Watching TV during meals was significantly associated with the consumption of chips and soft drink, however, watching television during family meals was associated with a more healthful diet than if the adolescent was not eating regular family meals [97]. The Project EAT study in Minneapolis collected a lot of data around family meals and concluded that regular shared dinnertimes were positively associated with intake of fruit, vegetables, whole grains and calcium-rich foods; and inversely associated with soft drink consumption [66, 95, 98, 99]. A focus group with adolescents summarised the reasons for not eating regular family meals and these include parent and teen schedule differences, teenagers wanting to be independent, issues with family relations, disagreement about foods served at dinner and long parent working hours [100]. The current theory explaining the link between regular family meals and dietary intake is not well established. It has been suggested that family cohesion accounts for some of the observations, that is closer families would be more likely to engage in healthful behaviours due to better parent modelling, clear mealtime expectations and a positive atmosphere, but this has not supported by a recent study [101].

Summary
In summary, this “family food habits” session focuses on the eating behaviours that have been linked to overweight and obesity in adolescents. This session covers family eating habits and encourages consumption of a healthy breakfast, limiting consumption of fast food, positive parent modelling and regular family mealtimes. In any case, “the establishment of permanent healthy lifestyle habits is a good outcome, regardless of weight change, because of the long-term health benefits of these behaviours” [11] page S181.

In the next few nutrition sessions we will consider ways to limit fast food intake and teach participants to make healthier takeaway and quick food choices. We will also be looking at food labelling and assessing the sugar content of drinks. The eating behaviours covered in this session are part of the monitoring form used in the last half of the program and will be mentioned again next week.

References


Key concepts: Supermarket Tour

- The supermarket is the perfect setting to consolidate new skills around food budgeting, label reading and making healthy choices
- Parents appreciate having time to compare different foods and labels
- Using nutrition information at the point-of-sale may help parents to make healthier food choices

Supermarket tours

Food choices made by individuals are influenced not only by personal factors (e.g. taste) but also by environmental and social factors (e.g. cost and shopping habits), as explained using the Social Ecological Theory [32, 61]. Given that 59% of grocery purchases are unplanned, research suggests that food purchasing behaviour can be influenced right up until the point of purchase [102]. Supermarket tours are one method that can be used to influence food choices in the supermarket aisles.

There is limited research into the effectiveness of shopping or supermarket tours as a tool for improving dietary quality, however, anecdotal evidence suggests that parents find them educational and interesting. Studies of the impact of nutrition information provision at the point-of-sale suggest that this information helps consumers to make healthier food choices [76, 103, 104]. Educating parents in the supermarket has shown to increase. Research also suggests that food labelling can confuse consumers [75, 77, 105, 106], therefore having a dietetic professional present can help parents to correctly understand the information available on the supermarket shelves and give them an opportunity to evaluate their usual purchases [72]. Previous CAFAP parents have identified that they don’t have time in their usual routine to look at new food products or think about new ways of doing their grocery shopping. Despite limited research into the link between food shopping practices and diet quality [107], supermarket tours are seen as a good way for parents to practice their new skills in food label reading and budgeting.

Food Cents is a program designed initially to improve the healthful dietary behaviours of low income families and is now widely available to “promote a healthy way of eating to people wanting to save money on their food budget” [72]. Healthful eating is not necessarily a more expensive way of eating and with education, families can manage their budget and improve their diets [74]. The supermarket tour component of FoodCents has been adapted and modified for use with parents of overweight teenagers in CAFAP.

Perceived cost barriers

In focus groups, women from low SES backgrounds rated cost as the most influential factor on their grocery food choices [59]. Parents often perceive healthy foods to be more expensive than unhealthy foods, however, with smart shopping practices (e.g. choosing seasonal fruits and vegetables), healthy foods are often cheaper and obviously more nutritious [59]. If women incorrectly perceive the cost of fruit to be too much, then they are more likely to be low fruit consumers [68]. This perceived environmental barrier may reflect a poorer availability of fruit and vegetables in the homes of families from lower SES brackets [69] and given that this is one of the strongest correlates with intake for adolescents [64, 67, 69], parent
education is of high importance.

The evidence around reduced diet quality in low SES families, coupled with higher rates of overweight, perceived higher cost of food and greater financial restrictions, indicates that this an important area for nutrition professionals to provide education and skills training to promote healthy eating [73]. Using the Health Belief Model as a guide, parents need to develop strategies to overcome potential barriers and improve their self-efficacy [67] and this can include education and training at the supermarket, focusing on purchasing seasonal fruits and vegetables, using effective food budgeting strategies and choosing foods that provide healthy value for money [59, 67, 71, 105].

Summary

This session gets parents into the supermarket to evaluate and compare common food items based on nutrition and price. This session complements previous sessions on healthy eating, food labelling and budgeting.

References

13. Foley, R.M. and C.M. Pollard, *Food Cents$— implementing and evaluating a nutrition education project focusing on value for money*. Australian and New


Key concepts – Nutrition: Recipe ideas

- Recipes can be modified to reduce the total energy content
- Reducing the amount of fat and sugar in a recipe will reduce the energy content, without reducing nutrition content
- Building parent confidence and skills is important to help parents to create healthy environments

An intake of foods high in fat and high in energy has the potential to lead to passive overconsumption which can contribute to the energy imbalance that precedes weight gain [4, 5]. These foods are often termed ‘extra’ foods or ‘junk’ foods given their high energy density but low nutrient density [6, 7]. The nutrition component of CAFAP focuses on reducing total energy intake by reducing the intake of fats and sugars and increasing the intake of fruits and vegetables [21-25]. This session looks at recipes that parents have used before; reducing the amount of fats and sugars, and often adding more nutritious ingredients including fruits and vegetables.

Using the Health Belief Model as a guide, parents need to develop strategies to overcome potential barriers and improve their self-efficacy relating to healthy food choices [67]. The development of skills relating to preparation of healthy family meals and snacks is an important part of this [12, 67].

Summary

In summary, this “recipe modification” session helps parents to develop skills in adapting recipes to reduce the energy content. This reinforces the overall concepts of the nutrition part of CAFAP and builds on what was learnt in the first few sessions about energy balance.

References


Appendix M

CAFAP food record
FOOD DIARY

Started Diary on ______________(date)

Finished Diary on ______________(date)

Name: _________________________
Telephone number: _________________________
Email: _________________________

Please call Kyla or Debbie if you have any questions:
9266 3694 or 9266 9456

Office use only

Wave____  Assessment______  ID code______
<table>
<thead>
<tr>
<th>Normal day?</th>
<th>Yes</th>
<th>No</th>
<th>Why not?</th>
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Where they have been bought:

- With take-away, please write what they are and margarine
- Flora, margarine
- Egg/ Henderson white spread with Flora canola
- Egg/ chicken breast, no skin, panfried with olive oil

Each item:

- Record the type and brand and cooking method of
- Give a full description of your food or drink
- Try to keep the diary with you at mealtimes
- Record each item as soon as you eat or drink it

Choose one weekend day and 2 weekdays.

Drink for three consecutive days.

Please record everything that you eat and drink.

Guidelines for keeping your 3-day food diary.
<table>
<thead>
<tr>
<th>Time</th>
<th>Description</th>
<th>Quantity</th>
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<tbody>
<tr>
<td></td>
<td>eg Weetbix</td>
<td>eg 3 biscuits / 45g</td>
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</table>

**DESCRIBE THE AMOUNT OF FOOD YOU EAT**

- If there is a weight on the packet, please write this down.
- Do your best to record the amount in household measures (for example: cups, spoons, volume or teaspoons).
- Estimate the ingredients of a mixed dish separately.
  - Eg/ a salad with 1 lettuce leaf, ½ tomato and 3 slices of cucumber lightly dressed with Praise French dressing.
- Remember to include accompaniments such as; butter, gravies, salt, butter added to vegetables, milk and sugar in coffee.
- Record all fluids even water and estimate the volume consumed in cups* or mls. Indicate the size of the cup (eg a middi glass, a paper cup, coffee mug).
- Record all recipes where possible: there is a ‘recipes’ section at the end of the booklet.

**PLEASE REMEMBER TO INDICATE IF THIS IS A NORMAL DAY OR NOT (eg/ birthday party, sick day, sports carnival)**
<table>
<thead>
<tr>
<th>Time</th>
<th>Description</th>
<th>Quantity</th>
<th>Food and Drink Consumed</th>
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**Day 2 Continued**

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**Do your very best!**

**Voucher:** Amount of effort you have put in will earn you a $5 gift.

A detailed food diary will earn you a $10 gift voucher.

A food diary that is not as detailed but still shows the types of food are recorded. Please put as much detail as you can into your food diary. Amounts are recorded in as much detail as possible.

- Eg/ white sugar
- Types of food are recorded
- Eg/ Brownies calcium plus milk
- Brands are recorded where possible
- There is a clear description of all foods

This is an example of recording breakfast. See how:
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<th>Time</th>
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<tr>
<td>7am</td>
<td>Cornflakes - Kelloggs</td>
<td>1.5 cups</td>
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<td></td>
<td>Milk - Brownes Calcium Plus</td>
<td>1 cup</td>
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<td></td>
<td>Sugar - white</td>
<td>2 tsp</td>
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<td>Toast, white bread - Helgas</td>
<td>2 large thick slices</td>
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<td></td>
<td>Margarine - Flora Light</td>
<td>3 teaspoons</td>
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<tr>
<td></td>
<td>Tea - Lipton</td>
<td>1 cup</td>
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<tr>
<td></td>
<td>Milk - Brownes Skim</td>
<td>30ml</td>
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<tr>
<td></td>
<td>Sugar - white</td>
<td>3 tsp</td>
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Appendix N

CAFAP assessment protocol
CAFAP Assessment Protocol

CAFAP Testing

FYI - All new appointments will have been sent/received -
1. An appointment email/phone call with instructions of location of the Assessment place.
2. Participant Information Sheet and Consent/Assent Form (Entry Assessment only)
3. Timeline for Participants (Entry Assessment only)

Before beginning Entry Assessment only - Show them a copy of emailed ‘Participant Information Sheet’ and ‘Consent/Assent Form’ Ask if they have read and understood it? Do they have any questions? etc
   • This Consent/Assent form must be signed and collected prior to commencing assessment.

At the end of the Assessment the families are to be shown –
   • a copy of emailed ‘Timeline for Participants’ which shows the overview of the full 18 month CAFAP program. Check understanding of the program and where they positioned at this stage.
   • Go through the Protocol for Food Diary
   • Go through the Protocol for Activity Monitor and Activity Diary

Things to take home following Assessment:
- Food Diary and measuring cups
- Activity Monitor, Activity Diary, Express Post envelope and bubble padding

Area/Equipment Required For Testing

Area required:
   • Running pathway – more than 10 m clear space for shuttle test (MSWT)
   • Wall for vertical jump test (Wall preferably not curved and must be high enough for participant to perform jump test without touching ceiling at maximal jump height).
   • Seating with tables for completing questionnaires
**Equipment:** (see Data Collection - Test Equipment List in the equipment crate)

<table>
<thead>
<tr>
<th>Data Collection Recording sheet</th>
<th>Stadiometer or tape measure</th>
<th>2 yellow cones/markers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pencil case- Pens, pencil</td>
<td>Dressmaker tape measure</td>
<td>MP3 + speaker (or CD player)</td>
</tr>
<tr>
<td>Adolescent Questionnaire</td>
<td>Digital bathroom scales</td>
<td>Modified Shuttle Walking Test (MSWT) MP3 (USB charged up?) (or CD)</td>
</tr>
<tr>
<td>Parent Questionnaire</td>
<td>Masking tape</td>
<td>Stop watch</td>
</tr>
<tr>
<td>Manual Muscle Tester (MMT)</td>
<td>Exercise mat</td>
<td>Children’s Effort Rating Table (CERT)</td>
</tr>
<tr>
<td>Chalk and Ruler</td>
<td>Your watch with a Second Hand</td>
<td>Pulse Oximeter Tuffsat</td>
</tr>
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</table>

**At the centre** - Chair (stable - no wheels for MMT) – Tables and chairs (for questionnaire completion)

*Remember to clean chalk off wall. (Water on Chux should do it)*

**TESTING PROCEDURE**

1. **Parents and adolescents** fill in relevant Questionnaire booklet
   - Check you have the correct Questionnaire booklet for this particular assessment
   Either - Entry / Pre-program / Post-program / 3 month / 6 month / 12 month
   - Please ask subjects to put their name and date on them and also please check that they have been filled out completely / correctly (e.g. Any answers missing? Only 1 answer in each line?)

2. **Height and weight measures** taken using digital scales and stadiometer*
   - Prior to measurement ask participants to remove shoes, excess clothes such as jackets or jumpers. Always ask them to empty pockets as they often have phones, keys, money and MP3 players etc. in them.
   - Please record which digital scales you use (eg Homemaker Co or Mi).
   - Record weight (to nearest 0.1kg) and height (to nearest 0.1cm) on data collection sheet (This will be used to calculate BMI)
   - When recording height ask participant to stand tall, eyes ahead and chin horizontal.
   (*In the event that there is no access to stadiometer, place ~ 5cm masking tape vertically on wall, have subject stand spine against wall, place clipboard on its edge 90° on top of their head and up against wall, mark tape, use metal measuring tape to nearest 0.1 cm from floor to mark)

3. **Waist Circumference** (This can be a sensitive measure so make sure you are in a private space).
• Waist – measure at level of umbilicus underneath clothes and remember to ask the subject to stand straight (not looking down!) and **breathe out** not in. Make sure there are no twists in tape measure and that tape measure is at equal level (horizontal) for whole circumference - viewing from both sides can ensure this. Or if not possible e.g. due to high buttocks - record their narrowest measurement in the appropriate place.
• Record measurement to the nearest 0.1cm.

4. **Muscle strength** – test with either the Lafayette digital MMT or the Nicholas MMT (record which you use)

• When testing, examiner needs to apply fairly strong pressure from saying “GO” otherwise participant will not build up to maximal contraction by end of test - when Lafayette MMT double beeps. N.B. The Nicholas MMT doesn’t beep – you press/match their pressure for about 3-4 seconds then record the highest score reached.
• **N.B. The test is done and recorded on non-dominant side**
• However, **begin** each Test Area by doing a **Practice Test** on their **dominant** (writing hand) side. (Circle L or R on data sheet) Ask participant if they felt they gave a maximal contraction to help ascertain if you applied enough pressure.
• Test as per MMT Testing Protocol on following page. Record on sheet
• **Test 3 times** with a short rest in between
• Verbal encouragement can be used
• Use whatever command gets you a good isometric contraction. “And go” works well.

**MMT TESTING PROTOCOL for Testing 3 Areas (Qs, Bs, Ds)**

Lafayette MMT- Switch on and check it is in kg mode. Press the Reset button (on top of unit) to retest. Remember to turn Off at end of each MMT testing session.
Nicholas MMT- has 2 buttons only. Use the ON/Reset button (not test button) It has auto Off.

**For quadriceps** (knee extensors), participants will sit upright in a regular chair (no movement) with thighs supported and hands rested lightly on the thighs, *palms up* (not like the pic below!) and feet flat on floor.

The participant will be directed to extend (straighten) their knee fully and the Myometer will be applied to the anterior (front) lower limb just above the malleoli (ankle).

The tester will need to place one stabilising hand above the knee on the side being tested.

The participant will try and maintain that position as the tester applies resistance in the opposite direction at the ankle.
Ask participant to match your resistance, aiming for a maximal contraction (The more they resist the harder you push. You can give encouragement such as repeating ‘push’ or ‘hold’).

N.B. The Lafayette MMT will double beep when measurement is recorded and you can remove force, then give short rest and repeat.

The Nicholas MMT doesn’t beep – you press/match their pressure for about 3-4 seconds then record the highest score reached. (keep watch during test)

The lower limb not being tested must remain still at all times (Backman, Odenrick et al. 1989).

**Practice on dominant side first** (It will help if you ask participant if they felt they gave a maximal contraction to help ascertain if you applied enough pressure. The test is done and recorded on non-dominant side 3 times.

For **biceps** (elbow flexors), participants will be positioned with their non-testing arm relaxed by their side and with the testing arm in 90° of elbow flexion (elbow bent at right angle) and supinated (forearm facing up toward ceiling),

The researcher will stabilise the testing arm posteriorly (from behind) superior (above) to the elbow, ensuring the elbow remains free to move.

The Myometer will be applied on the forearm just proximal to the radial styloid process (just above wrist). The participant will be instructed to keep their elbow flexed at 90° as resistance is provided by the researcher in the opposite direction.
Ask participant to match your resistance (The more they resist the harder you push, you can give encouragement such as repeating ‘push’ or ‘hold’).

The Lafayette MMT will double beep when measurement is recorded and you can remove force, then give short rest and repeat. (Backman, Odenrick et al. 1989)
The Nicholas MMT doesn’t beep – you press/match their pressure for about 3-4 seconds then record the highest score reached. (keep watch during test)

**Practice on dominant side first** (will help if you ask participant if they felt they gave a maximal contraction to help ascertain if you applied enough pressure.
The test is done and recorded on non-dominant side 3 times.

Figure 2.0 Biceps Manual Muscle Testing (participant’s hand should be palm facing up)
For deltoids (shoulder abductors), participants will be seated with the testing shoulder abducted (arm held out to side away from body) to 90°, elbow extended (straight), forearm in mid-pronation (palm down). The non-testing arm remains rested palm up on participant’s lap.

It is usually easier to apply test from standing behind participant. The researcher will stabilise the testing shoulder (by placing flat hand over shoulder), ensuring the shoulder remains free to move (may need to move hand closer to neck to allow movement). The Myometer will be applied to the upper limb approx 2cm proximal to the lateral humeral epicondyle (above elbow joint). The participant will be instructed to maintain the testing position as resistance is provided by the researcher in the opposite direction.

Ask participant to match your resistance (The more they resist the harder you push, you can give encouragement such as repeating ‘push’ or ‘hold’). The Lafayette MMT will double beep when measurement is recorded and you can remove force, then give short rest and repeat.

The Nicholas MMT doesn’t beep – you press/match their pressure for about 3-4 seconds then record the highest score reached. (keep watch during test)

Practice on dominant side first (will help if you ask participant if they felt they gave a maximal contraction to help ascertain if you applied enough pressure. The test is done and recorded on non-dominant side 3 times.

Figure 3.0 Deltoid Manual Muscle Testing
5. **Muscle Endurance** – Abdominal Curl Up Test

- Measurement will be taken from the number of curl-ups performed correctly in 1 minute.
- Curl-ups need only be counted where the head is lifted off the mat; shoulders are raised above two inches; the heels stay on mat.
- Adolescent lies supine on the mat with knees at 90°.
- Arms at the side with fingers touching a 10cm long masking tape situated perpendicularly to the fingers on both sides.
- A second piece of masking tape is situated at 8cm parallel from the first for participants to reach toward.
- Participant to perform slow and controlled curl-ups, lifting the shoulders off the mat, trunk 30° to mat.
- Ensure that the upper back is lowered to touch the floor before each curl-up.
- Record how many correct sit-ups are completed in one minute.

Figures 4.0 and 5.0 show the start position and curl up position respectively.

(N.B. tape should be on both sides (not shown in photo!))

**Figures**

- **Figure 4.0 Start position**
- **Figure 5.0 Partial curl up**
6. **Vertical Jump** - (they can choose which arm they want to use)
   - Ask participant to stand side-on next to a wall and reach arm up vertically with shoulder at 180 degrees shoulder flexion (arm by ear) and fingers pointing up wall with a flat hand. Using chalk, mark a thin line on the wall at the top of their middle finger (shoulders relaxed)

**N.B.** If the wall/brick doesn’t show the dust mark they can **hold** a small piece of chalk for the test instead.

   - Place chalk dust on the pad-tip of the same middle finger of this arm.
   - Using an arm swing, knee bend action, get them to jump up, sweeping their hand against the wall at the highest point to mark how high they have jumped (a sweeping action gets best result).
   - Record three attempts (√ each jump)
   - Measure the vertical distance between base chalk and the highest jump’s chalk mark. Record to nearest 0.1cm. (a ruler is useful)

7. **10m Modified Shuttle Walk Test (MSWT)** – between the two yellow cones

   - Measure and mark a 10m distance and tape the end lines. Place a yellow cone on each end.
   - One shuttle is one 10 metre walk (or jog/run -depends on level).
   - Pre - Ask participant to rate exertion on Children’s Effort Rating Table (CERT)
   - Pre - Take participant’s heart rate (HR)* You may use Pulse Oximeter Tuffsat. Push large black button to turn ON. Place clip on pointer finger with cable above the nail.

   *Record the number that appears below the ♥ after 15 seconds (beware it’s not top number which is the oxygen!)*

   - Explain to participant that the HR and CERT will be taken again at the end of the MSWT and after 1 minute
   - Play the MP3 / CD for the MSWT which will give all instructions needed. They may need help when to start ->> It’s on the triple beep after 4 single beeps.

   - They must **stop** once they no longer make it **within 0.5m of a cone on the beep** or when they are too tired to continue. Record only the fully completed shuttles.
   - Post - **Immediately** after stopping->> take post heart rate(HR) ♥

     *Record reading after 15 seconds and have participant rate CERT and then*

     *... leave the oximeter on finger ... because...*

   - Post - **At 1 minute** after stopping->> Take 1 min post heart rate(HR) ♥

     *Record reading after 15 seconds and have participant rate CERT*

**Notes**
• **Wear a watch with Second Hand** - easier for timing the HR (15 secs) at Pre, Post and 1min Post

PTO > > ........ for more notes!

**MSWT Continued**

- Verbal encouragement can be used.
- **Each triple beep indicates another level.** It is helpful to tell participants they have made it to another level. There are 15 levels for the MSWT. There are 3 shuttles for Level 1 and an *extra shuttle* is added at each new level.
- They will need to go faster at each new level and move into a jog/ run in the higher levels.
- Record how many **successful** shuttles at each level on the data collection sheet.

**Table 1.0 Example of Recording –**

This participant stopped in Level 8 and did **not** finish the 7th shuttle

<table>
<thead>
<tr>
<th>Level</th>
<th>Shuttles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>✠</td>
</tr>
<tr>
<td>2</td>
<td>✠ ✠ ✠</td>
</tr>
<tr>
<td>3</td>
<td>✠ ✠ ✠ ✠</td>
</tr>
<tr>
<td>4</td>
<td>✠ ✠ ✠ ✠ ✠</td>
</tr>
<tr>
<td>5</td>
<td>✠ ✠ ✠ ✠ ✠</td>
</tr>
<tr>
<td>6</td>
<td>✠ ✠ ✠ ✠ ✠</td>
</tr>
<tr>
<td>7</td>
<td>✠ ✠ ✠ ✠ ✠</td>
</tr>
<tr>
<td>8</td>
<td>✠ ✠ ✠ ✠ ✠ ✠</td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

→ **Record - Level 8 ; 6 Shuttles**
8. **Food record** – give the adolescent a food diary to complete at home.

- The food diary is kept over three consecutive days, one of which needs to be a weekend day (i.e. Thu, Fri, Sat or Sun, Mon, Tue). Choose these days for the week ahead and record on the data collection sheet.
- Encourage the teenager to record **every** food and drink consumed during these 3 days.
- Explain to the adolescent that they shouldn’t change their eating habits. They won’t be judged on what they eat, they just need to eat as normally as they can.
- Explain that the food diary needs to include detailed information e.g. a sandwich needs to be broken down into individual components- 2 thick slices of white bread, thick spread of flora margarine, 2 medium lettuce leaves, 2 thick slices of Bega cheese, 2 medium slices of tomato.
- Give the participants a set of measuring cups to keep, to help them record their food diaries.
- The food diary needs to be posted back with the Actical.

9. **Actical** – will have been pre-programmed for the child before the test.

- At the end of the test give the subjects the Actical with the appropriate size waist belt. Demonstrate and show correct position before asking them to put it. They can step into it/put on over their head to avoid undoing/redoing the buckle every time. Then adjust the Velcro to fit.
- The arrow on the Actical must always be **pointing up**
- It is worn on the Right A.S.I.S. (forward R hip bone) under or over their clothes.
- The belt buckle will be **in front** of them- near and just below their belly button
- Actical is worn for a full week i.e. 7 full days
• Ask them to put it on as soon as they get up each day and then take it off last thing when they go to bed (or they may leave it on overnight as well)
• A diagram of where to wear it is on the next page
• It is waterproof so they can swim with it on, they just need to dry the belt by wringing/squeezing it in a towel
• See Protocol for explanation to the participant on next page

Activity Monitor and Activity Diary Protocol - show to participant

Please fix the activity monitor correctly onto the belt. (if not already prepared)

Place it in the gap between the 2 Velcro strips to the left of the buckle (arrows pointing up). Thread left Velcro strip through left side of the monitor and do same on right side.

Activity Monitor explanation

1) The waist activity monitor should sit on the front bony part of the right hip, with the arrow always pointing upwards. The belt buckle sits in front of you, near and below the belly button.

2) We would like you to keep this activity monitor on for the entire week. It's robust - you can wear it while you are playing sport and it is fine for general water sports, except diving. If you like, you can take it off when you are having a shower and sleeping - just remember to write this down in the activity diary so that we know you've taken it off. We'd really like you to keep it on every other time though, so we can keep track of how active you have been. Remember to dry the straps (by squeezing it with a towel) when you dry yourself if you leave it on in the pool or shower, otherwise it'll get smelly.
• **Activity Diary explanation**

1. We are interested in the physical activities that you do - especially the times that you are doing activities that make you huff and puff/sweat.

2. Look at the Activity Diary example- see how a participant filled out the times when she/he put on and took off her/his activity monitor and also noted any **physical activities** they did that made them huff and puff (including time of activity).

3. Find □ below. You should place a tick in the appropriate box indicating if it is a **normal** school day/weekend day or if you were doing **something different** (e.g. Sports day, Carnival day, Pupil Free day, public holiday, sick day, went camping/hiking etc…)

4. Find **Day 1** on the Activity diary. This will be your first Activity Monitor and Activity Diary day (tomorrow). Fill out the dates on the diary if not already done. **If you miss a day** then you will need to make a note that you have missed Day # and change the following numbers to allow for the missed one. Wear the monitor one more day to make up for it- so there are 7 days of wearing it.
Appendix O

CAFAP short eating behaviours questionnaire
### Eating Behaviours

**How many times a week do you usually have something to eat for breakfast?**

- [ ] Every day
- [ ] 5-6 days per week
- [ ] 3-4 days per week
- [ ] 1-2 days per week
- [ ] Rarely or never eat breakfast

**How many times a week do you usually have something to eat for dinner (or the evening meal?)**

- [ ] Every day
- [ ] 5-6 days per week
- [ ] 3-4 days per week
- [ ] 1-2 days per week
- [ ] Rarely or never eat dinner

**How many times a week do you usually eat dinner with most of your family?**

- [ ] Every day
- [ ] 5-6 days per week
- [ ] 3-4 days per week
- [ ] 1-2 days per week
- [ ] Rarely or never eat dinner with my family

**How many times a week do you usually eat dinner in front of the television?**

- [ ] Every day
- [ ] 5-6 days per week
- [ ] 3-4 days per week
- [ ] 1-2 days per week
- [ ] Rarely or never eat in front of the television
How many times a week do you usually eat food from a fast food outlet (like McDonalds, Hungry Jacks or KFC)?

☐ Every day
☐ 5-6 days per week
☐ 3-4 days per week
☐ 1-2 days per week
☐ Rarely or never eat fast food

How many times a week do you drink soft drinks (not diet), fizzy drinks, sports drinks or sweet drinks like cordial, lemonade or Gatorade?

☐ Every day
☐ 5-6 days per week
☐ 3-4 days per week
☐ 1-2 days per week
☐ Rarely or never drink sweet drinks

How many serves of fruit do you usually eat each day? (1 serve = 1 medium piece of fruit or 2 small pieces of fruit or 1 cup diced fruit pieces)

☐ I don’t eat fruit
☐ 1
☐ 2
☐ 3 or more serves of fruit

How many serves of vegetables do you usually eat each day? (1 serve = ½ cup of cooked vegetables or 1 cup of salad vegetables. Do not count French fries, potato chips or onion rings)

☐ I don’t eat vegetables
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5 or more serves of vegetables
How many serves of junk food do you usually eat each day? (1 serve = 1 doughnut, 1.5 chocolate biscuits, 1 snack pack of potato crisps or 1 can of soft drink)

☐ I don’t eat junk food
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5 or more serves of junk food
Appendix P

CAFAP post hoc analysis for Study D
Exploratory post hoc analysis was conducted to assess whether adherence to key dietary intervention messages was related to ‘autonomous motivation’ or ‘perceived parent support for healthy eating’. These two constructs were assessed as part of the psychological measures used in CAFAP. The two measures are included below, along with the results from the post hoc analysis.

Your motivation for healthy eating

In this section you will be presented with reasons why you eat healthy. You are asked to indicate how true each reason is for you.

<table>
<thead>
<tr>
<th>I eat healthy because...</th>
<th>Not true at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>...I enjoy eating healthy</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>...I value the benefits of eating healthy</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>...I will feel guilty if I do not eat healthy</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>...others want me to eat healthy</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>...I don't see why I should eat healthy</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>...it's fun to eat healthy</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>...I think it's important to make the effort to regularly eat healthy</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>...I will feel bad with myself if I do not eat healthy</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>...people I know well say I should eat healthy</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>...eating healthy gives me a sense of well-being</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>...I can't see why I should bother eating healthy</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>...it's important to me to eat healthy on a regular basis</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>...I will feel ashamed if I do not eat healthy</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>...I feel under pressure to eat healthy from</td>
<td>1 2 3 4</td>
</tr>
</tbody>
</table>

Remember: Eating healthy is defined as sufficient fruit and vegetables and few high fat foods.
people I know well

<table>
<thead>
<tr>
<th>Item</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think eating healthy is a waste of time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>it’s part of the way in which I have chosen to live my life</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I don’t see the point in eating healthy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>it’s an important part of who I am</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>it’s essential to my identity and sense of self</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>eating healthy is consistent with my deepest principles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>it’s an extension of me</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- This measure is scored using a weighted index from -3 (amotivation) to 3 (intrinsic motivation)

This questionnaire was based on an adapted version of Mullan, Markland, and Ingledew’s (1997) Behavioural Regulation in Exercise Questionnaire (BREQ) and Ryan and Connell’s (1989) Perceived Locus of Causality for Diet and the Integrated Regulation Scale for Exercise Behaviour (McLachlan et al., 2011). It was used to measure autonomous motivation for healthy eating.


Perceived parent support for eating healthy

This section asks you to reflect on the behaviours demonstrated by your parent in regard to your healthy eating. When answering the questions, please refer to your parent who plans to attend the majority of the CAFAP sessions. Please indicate the degree to which you agree with the following statements.

Remember: Eating healthy is defined as sufficient fruit and vegetables and few high fat foods.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>I felt my parent provided me with choices, options, and opportunities about whether to eat healthy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>My parent encouraged me to eat healthy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>My parent provided me with positive feedback about eating healthy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>My parent made sure I understood why I needed to eat healthy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>I think the my parent understood my choices for eating healthy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>My parent was concerned about my well-being experiences when I ate healthy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>My parent cared about the healthy eating I did</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>My parent listened to me about my eating healthy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>I felt I was able to share my experiences of eating healthy with my parent</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Question</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
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<td>---</td>
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<td>---</td>
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<td>---</td>
</tr>
<tr>
<td>My parent displayed confidence in my ability to eat healthy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My parent gave me good advice about eating healthy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My parent gave me clear and understandable instructions about eating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My parent made it clear to me what to expect from eating healthy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My parent provided clear answers to my questions about eating healthy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This questionnaire is a modified version of the PASSES (Hagger et al., 2007) and PESS (Markland & Tobin, 2004a) and was used to measure adolescents’ perceived need-support from parents with regard to adolescents’ healthy eating behaviours.


In the post hoc analysis, participants were defined as adhering to each of the dietary intervention messages if they increased their intake of fruit or vegetables by 0.25 servings, or reduced their intake of junk foods by 0.5 servings. Participants were then split into two groups based on whether they had or had not adhered to each of the key dietary intervention messages. For each group, means were calculated for Motivation for Healthy Eating and Perceived Parent Support for Healthy Eating at both post-intervention and 12-months post-intervention. The group means were compared using a t-test and p values reported to identify statistically significant differences between the groups. The table below shows that there were no differences in motivation or perceived support between participants who did adhere and those who did not adhere to each of the key dietary intervention messages.

The relationship between motivation or parent support with adherence to key dietary messages

<table>
<thead>
<tr>
<th></th>
<th>Motivation for healthy eating post-intervention</th>
<th>Perceived parent support for healthy eating 12-months post-intervention</th>
<th>Motivation for healthy eating post-intervention</th>
<th>Perceived parent support for healthy eating 12-months post-intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eat more fruit</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adhered</td>
<td>6.4</td>
<td>5.9</td>
<td>4</td>
<td>5.5</td>
</tr>
<tr>
<td>Did not adhere</td>
<td>5.3</td>
<td>5.9</td>
<td>6.5</td>
<td>5.9</td>
</tr>
<tr>
<td>p value</td>
<td>.54</td>
<td>.94</td>
<td>0.15</td>
<td>.40</td>
</tr>
<tr>
<td><strong>Eat more vegetables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adhered</td>
<td>7.6</td>
<td>6.2</td>
<td>4.5</td>
<td>5.7</td>
</tr>
<tr>
<td>Did not adhere</td>
<td>4.4</td>
<td>5.6</td>
<td>5.9</td>
<td>5.8</td>
</tr>
<tr>
<td>p value</td>
<td>.06</td>
<td>.14</td>
<td>0.42</td>
<td>.90</td>
</tr>
<tr>
<td><strong>Eat less junk food</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adhered</td>
<td>7.1</td>
<td>6.1</td>
<td>5.3</td>
<td>5.9</td>
</tr>
<tr>
<td>Did not adhere</td>
<td>3.5</td>
<td>5.5</td>
<td>5.4</td>
<td>5.6</td>
</tr>
<tr>
<td>p value</td>
<td>.05</td>
<td>0.18</td>
<td>0.97</td>
<td>.66</td>
</tr>
</tbody>
</table>

*p values compare group means for participants who adhered and participants who did not adhere to the key dietary intervention messages*
Appendix Q

CAFAP text messages sent during the maintenance period
<table>
<thead>
<tr>
<th>Message Number</th>
<th>Message Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hope your goals are going well this week as you enjoy school holidays. Debbie will be calling sometime in the next few days to see how things are going.</td>
</tr>
<tr>
<td>2</td>
<td>After dinner can be a good time to eat some fruit. If you had less than 2 bits of fruit today, you might like some tinned apricots &amp; yoghurt for dessert?</td>
</tr>
<tr>
<td>3</td>
<td>How about chatting with your parent(s) this weekend about what your goals are for this week.</td>
</tr>
<tr>
<td>4</td>
<td>What is your activity goal for today and tomorrow? How about arranging to be active with someone?</td>
</tr>
<tr>
<td>5</td>
<td>Have you sat for more than 30 minutes at a time watching TV or playing on a computer today? See if you can have an active break every 30 minutes this evening.</td>
</tr>
<tr>
<td>6</td>
<td>How many steps have u done already today? How about trying to do 5,000 this afternoon?</td>
</tr>
<tr>
<td>7</td>
<td>What was your sedentary behaviour goal for today? Did you achieve your goal?</td>
</tr>
<tr>
<td>8</td>
<td>Some teenagers have told us that cut up fruit salad for recess helps them reach their healthy eating goals. What about taking some tomorrow?</td>
</tr>
<tr>
<td>9</td>
<td>How many vegies have u had today? If you’re a bit behind with your 5 serves, why not choose to have some tomato and cucumber in your sandwich at lunch?</td>
</tr>
<tr>
<td>10</td>
<td>What are the reasons you want to be more active? You might like to think about these when the going gets tough!</td>
</tr>
<tr>
<td>11</td>
<td>A CAFAP teen has found using an egg-timer is a good way of knowing it’s time for an active break after playing on the computer for 30mins. You could choose to try it too.</td>
</tr>
<tr>
<td>12</td>
<td>Have a look at your goals for physical activity, sedentary behaviour and healthy eating. Plan something fun to do this weekend to help meet your goals.</td>
</tr>
<tr>
<td>13</td>
<td>Remember the key messages of CAFAP are: eat more fruit and veg, eat less junk food, be less inactive and be more active.</td>
</tr>
<tr>
<td>14</td>
<td>What is your activity goal for today and tomorrow? How about setting your step counter to see how many steps you do tomorrow?</td>
</tr>
<tr>
<td>15</td>
<td>The CAFAP fruit muffins we made during the program are a great afternoon tea snack. You could make some today to help you achieve your goals for healthy eating!</td>
</tr>
<tr>
<td>16</td>
<td>Is there a friend or family member who could do some activity with you tomorrow to help you meet your goal?</td>
</tr>
<tr>
<td>17</td>
<td>Remember the benefits of breaking up sedentary time. How about making a game with your family to do a circuit exercise in each ad break on TV.</td>
</tr>
<tr>
<td>18</td>
<td>How much MVPA (huffing and puffing activity) have u done today? How about calling a friend to meet this arvo for an active game outside?</td>
</tr>
<tr>
<td>19</td>
<td>Think about how many bits of fruit u had today. If u had less than 2, you could try to add in 1 more piece tomorrow. How about some fruit on your cereal in the morning?</td>
</tr>
<tr>
<td>20</td>
<td>Other CAFAP teens tell us it’s easier to be active when you are doing it with family or friends. Perhaps you could arrange to do this tomorrow to help meet your healthy activity goals?</td>
</tr>
<tr>
<td>21</td>
<td>To help meet your sedentary behaviour goals, why not plan when your favourite TV shows are on this week and try to limit your TV to just these shows?</td>
</tr>
<tr>
<td>22</td>
<td>Do you remember that the benefits of being more active include having a healthier heart and body chemistry, feeling less tired, sleeping better, being happier and thinking better?</td>
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<tr>
<td>23</td>
<td>Think about how many vegies u had today. If u had less than your goal, try to add in 1 more piece tomorrow. How about some vegie sticks with one of the yummy dips u made at CAFAP?</td>
</tr>
<tr>
<td>24</td>
<td>You seemed to enjoy kicking a ball when at CAFAP sessions. You might like to plan some more this week to help you meet your healthy activity goals.</td>
</tr>
<tr>
<td>25</td>
<td>Remember the key messages of CAFAP are: eat more fruit and veg, eat less junk food, be less inactive and be more active!</td>
</tr>
<tr>
<td>26</td>
<td>Is there a friend or family member who could do some activity with you tomorrow?</td>
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<tr>
<td>27</td>
<td>Several of the teens wanted to keep in touch with each other, so we have set up a private CAFAP Facebook group. If you add Debbie Cafap as a friend she will add you to the private CAFAP group.</td>
</tr>
<tr>
<td>28</td>
<td>What is your sedentary behaviour goal for today? Did you achieve your goal?</td>
</tr>
<tr>
<td>29</td>
<td>How many steps have you done today? How about trying to do a few extra thousand steps this afternoon?</td>
</tr>
<tr>
<td>30</td>
<td>We have put a great recipe for healthy snacks on the CAFAP private Facebook group. Perhaps you could make some?</td>
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<tr>
<td>31</td>
<td>Bananas are a good price at the moment, why not ask your parents to buy some in this week’s shopping?</td>
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<tr>
<td>32</td>
<td>Have you sat for more than 30 mins watching TV/playing on a computer today? See if you can have an active break every 30 mins this evening.</td>
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<tr>
<td>33</td>
<td>Do you have a good idea for being active? How about sharing it with other CAFAP teens on the private CAFAP Facebook page?</td>
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<tr>
<td>34</td>
<td>What is your activity goal for tomorrow? How about setting up the step counter to see how many steps you do tomorrow?</td>
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<tr>
<td>35</td>
<td>How many serves of veg have you had today? How about some extra salad with dinner tonight?</td>
</tr>
<tr>
<td>36</td>
<td>What are your sedentary behaviour goals this week? Are they challenging enough for you? (CAFAP messages will only be coming each week from now on.)</td>
</tr>
<tr>
<td><strong>First weekly 37 (on start day)</strong></td>
<td>How about sharing a healthy snack idea with other CAFAP teens on the private CAFAP Facebook page?</td>
</tr>
<tr>
<td>38</td>
<td>Have a look at your activity and eating goals. What can your parent do this week to help you? Try to chat with them about it today.</td>
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<tr>
<td>39</td>
<td>Remember the benefits of breaking up sedentary time. How about making a game with your family to do a circuit exercise in each ad break on TV?</td>
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<tr>
<td>40</td>
<td>How much MVPA (huffing and puffing activity) have u done today? How about calling a friend to meet this arvo/later this week for an active game outside?</td>
</tr>
<tr>
<td>41</td>
<td>Do you have a good idea for being less inactive? How about sharing it with other CAFAP teens on the private CAFAP Facebook page?</td>
</tr>
<tr>
<td>42</td>
<td>Do you remember the benefits of being more active, being less inactive, eating less junk food and eating more fruit and veg? How about seeing if you remember more of them than your parent!</td>
</tr>
<tr>
<td>43</td>
<td>Have a think about your physical activity, sedentary behaviour and healthy eating goals. Plan something fun to do this weekend to help meet your goals.</td>
</tr>
<tr>
<td>44</td>
<td>Remembering the CAFAP classes, what was the activity you enjoyed most? How about adding some of this activity to your goals for this week?</td>
</tr>
<tr>
<td>45</td>
<td>Can you design a text message we could use to help other CAFAP teens to keep up with their goals when things get tough? If you think of a good one, why not send it to us?</td>
</tr>
<tr>
<td>46</td>
<td>What goals do you choose to aim for this week?</td>
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<tr>
<td>47</td>
<td>How about chatting with your parents today about your CAFAP goals for this week.</td>
</tr>
<tr>
<td>48</td>
<td>Which CAFAP healthy recipe have you enjoyed the most? How about making it this weekend?</td>
</tr>
<tr>
<td>49</td>
<td>What would be your best tip to other teenagers wanting to be more active, be less inactive, eat less junk food and eat more fruit and veg. Perhaps post it on the private CAFAP Facebook page?</td>
</tr>
<tr>
<td>50</td>
<td>This is the last weekly, CAFAP message – from now on they will be monthly. Keep up the good work with your goals!</td>
</tr>
<tr>
<td>First Monthly 51</td>
<td>Do you need to update your goals this month? Let us know if you would like some help.</td>
</tr>
<tr>
<td>52</td>
<td>How about taking a photo of you meeting one of your activity or eating goals – and post it on the private CAFAP Facebook page?</td>
</tr>
<tr>
<td>53</td>
<td>Being active and eating well will help you feel healthier and happier. What would you like to challenge yourself with this month?</td>
</tr>
<tr>
<td>54</td>
<td>What has been the best thing for you about being in CAFAP? How about sharing it with the other CAFAP teens on the private CAFAP Facebook page?</td>
</tr>
<tr>
<td>55</td>
<td>Have a look at your goals for being more active and less inactive and eating healthy. How about sharing your goals with the other CAFAP teens on the private CAFAP Facebook page?</td>
</tr>
<tr>
<td>56</td>
<td>This is the last CAFAP SMS. You have done really well. Remember - eat more fruit and veg, eat less junk food, be less inactive and be more active – and you will feel happier and healthier!</td>
</tr>
</tbody>
</table>
Appendix R

CAFAP text messaging focus group prompts
CAFAP 3 month post-program focus group

**Explain the general purpose of the discussion and why the participants were chosen:**

The purpose of this study is to understand more about the usefulness of text messages sent after the CAFAP program to encourage ongoing healthy change in teenagers, as well as understanding more about how teenagers experience recording their food intake using 3 day food records.

**Discuss the purpose and process of focus groups**

The focus group aims to:

- Explore opinions about the support provided after CAFAP, particularly the use of SMS
- Explore opinions about the ease and practicality of using 3 day food records to report accurate and usual dietary intake
- Explore the best options for mobile phone message frequency, timing and contact
- Test potential concepts for messages relating to activity, food and goal setting

- **Explain the presence and purpose of recording equipment**
- **Outline general ground rules and discussion guidelines**
  - Importance of everyone speaking up, no right or wrong answer, talking one at a time, being prepared for the moderator to interrupt to assure that all of the topics can be covered.
- **Address issue of confidentiality**
  - Inform the group that information is discussed is going to be analysed as a whole and participants’ names will not be used in any analysis of the discussion.

**Use a number of current CAFAP text messages (below) for feedback and ask about each one:**

Like/Dislike this message?

What would you first think when you got this message?

Is it a realistic message for you? (Is it right for you?)

What’s good about it?

What’s not so good about it?

Did it make you think about changing your behaviour (diet/activity/habit)?

How could we make it better?

*Messages are based on a selection of the texts sent during the high intensity phase that reflect the different key strategies in our protocol for SMS.*
Message 1: After dinner can be a good time to eat some fruit. If you had less than 2 bits of fruit today, you might like some tinned apricots & yoghurt for dessert? Message including a ‘helpful tip’

Message 2: A CAFAP teen has found using an egg-timer is a good way of knowing it’s time for an active break after playing on the computer for 30mins. You could choose to try it too. Testimonial message

Message 3: What are the reasons you want to be more active? You might like to think about these when the going gets tough! Intrinsic motivation, reflecting goal setting process used during the program

Message 4: How many steps have you done today? How about trying to do a few extra thousand steps this afternoon? Reflective questioning

Message 5: Have a look at your goals for physical activity, sedentary behaviour and healthy eating. Plan something fun to do this weekend to help meet your goals. Bigger picture, reinforcing key CAFAP areas and goal setting.

Message 6: How many bits of junk food have u had today? You could challenge yourself to see if you can go the rest of the day without any junk food. Some cut up fruit might be a sweet treat instead! Reflective questioning and ‘helpful tip’

Specific angles Following up on key principles that CAFAP have used in the texts above, with more of a focus on these specific principles

1. What did you think of messages that asked you a question? eg/ What was your sedentary behaviour goal for today? Did you achieve your goal?

2. What did you think of messages that reminded you about why being healthy was important? eg/ Do you remember that the benefits of being more active include having a healthier heart and body chemistry, feeling less tired, sleeping better, being happier and thinking better?

3. What did you think of the ‘big picture’ messages eg/ Remember the key messages of CAFAP are: eat more fruit and veg, eat less junk food, be less inactive and be more active.

4. What did you think of the messages that gave you healthy tips? Eg/ Think about how many vegies u had today. If u had less than your goal, try to add in 1 more piece tomorrow. How about some vegie sticks with one of the yummy dips u made at CAFAP?

5. What did you think of the messages that included ideas from other teenagers? Eg/ Some teenagers have told us that cut up fruit salad for recess helps them reach their healthy eating goals. What about taking some tomorrow?
6. What do you think about messages that are about what not to do? Eg/ Don’t eat junk food today or don’t spend the afternoon lying on the couch.

Other teens have said that even when you say “don’t do something” if it talks about temptations (like junk food or lounging by the TV), it makes you want to do that?

Is it more helpful to be positive and give you healthy ideas to try?

Overall, what do you think would be most helpful in a text message?

Did the text messages reinforce the things you learnt at CAFAP?

**General**

Do you think the messages should include exclamation marks? Smiley faces? Why?

Did the text messages get boring over time? Why?

How do we keep the text messages interesting?

Timing: 6pm, midday? How did these work for you? What were you doing at the time?

What would be better times?

How did the days work for you? What were you doing on these days? Were there days you needed the texts more than others?

Was it helpful for you to receive text messages from CAFAP? Why/ why not?

Did the messages help you set goals related to things you enjoy?

Did the messages help to motivate you to set goals to improve your health?

Can you remember a time when a CAFAP text message helped you to change your behaviour or stick to your goal?

What would you think about your parents getting the same texts as you, so that like in the program, they could help you more with supporting your goals?

How did you find the fortnightly phone calls from CAFAP?

    Were they useful, annoying, embarrassing, bad timing?

We’ve just started the CAFAP Facebook group. Have you had a look at the things posted?

What should we do to make the Facebook group fun and useful for you?
Prompts for parents- Key topics

How have you and your family gone during the 3 months post program? Positive experiences and difficulties.

In your opinion, have the texts/phone calls/Facebook support been helpful for your teen?

What could we do better in the three months post-program to help your teen stick with their goals?
Appendix S

Overview of studies B-E
The following diagram depicts an overview of the research project. Assessment time points are across the top of the following figure in grey. The key periods of the overall study are shown below this starting with the planning phase. This is followed by the three month waitlist control period and the intensive eight week intervention. The 12 month maintenance period is comprised of three months of high intensity support (dark grey), three months of medium intensity support (darker grey) and six months of low intensity support (darkest grey).

Study B (Chapter 4, light blue) examines the consumption patterns of overweight adolescents prior to intervention and uses baseline data from the beginning of the waitlist period.

Study C (Chapter 5, bright blue) details the changes in primary outcomes for the larger trial. Specifically, this paper examines fruit, vegetable and junk food consumption from baseline, across the intervention period and through the 12 month maintenance period.

Study D (Chapter 6, orange) examines the adherence of participants to the key dietary messages of the intervention changes as supported by changes in secondary outcomes of eating behaviours and nutrient intake. This study tracks dietary intake from baseline, across the intervention period and through the 12 month maintenance period.

Study E (Chapter 7, brown) considers the experiences of obese adolescents who had received tri-weekly text messages during the high intensity maintenance period (dark green) for the three months immediately post-intervention.

Beneath the assessment points are the number of study participants, with the shading correlating to the associated study. For example, Chapter 5 included results from 68 adolescents at baseline and 34 adolescents who remained at 12 months post intervention.
### Measures taken at:

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<thead>
<tr>
<th>Time Period</th>
<th>Baseline</th>
<th>Pre-intervention</th>
<th>Post-intervention</th>
<th>3 months post</th>
<th>6 months post</th>
<th>12 months post</th>
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<td>n=58</td>
<td>n=47</td>
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### Participant numbers in studies

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<th>Intervention Timeline</th>
<th>Planning</th>
<th>Waitlist</th>
<th>Intervention</th>
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### Calendar dates

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### Thesis components

- **Chapter 5. Changes in fruit, vegetable and junk consumption**
- **Chapter 6. Changes in other nutrition outcomes**
- **Chapter 4. Consumption patterns**
- **Chapter 7. SMS experiences**
Appendix T

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Study D has been published in Nutrients. The publishers of 'Nutrients' journal (MDPI) allow unrestricted archiving of published journals.

Study E has been published in the Journal of Medical Internet Research. The publishers of the ‘Journal of Medical Internet Research’ (Journal of Medical Internet Research) allow archiving of post-print journal articles.