School of Public Health
Collaboration for Evidence, Research and Impact in Public Health

Development, implementation and evaluation of a diet and physical activity intervention targeting rural Australian adults with or at risk of metabolic syndrome

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Doctor of Philosophy
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Author's 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.

The research presented and reported in this thesis was conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007) – updated March 2014. The proposed research study received human research ethics approval from the Curtin University Human Research Ethics Committee (EC00262), Approval Number HR149_2013.

The work described in this thesis was undertaken by the author and is original. The study design, ethics approval, data collection and analysis, writing of manuscripts for publication and writing of the thesis were conducted under the supervision of Associate Professor Jonine Jancey, Doctor Tony James, Professor Andy Lee, and Professor Peter Howat.

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Date: 8th September 2016

Abstract

Background

Metabolic syndrome (MetS) significantly increases the risk of developing type 2 diabetes mellitus (T2DM) and cardiovascular disease (CVD) due to the combined presence of dyslipidaemia, hyperglycaemia, and hypertension. Older adults in rural areas have a higher risk of MetS and associated chronic disease due to the increased prevalence of poor diet, physical inactivity, sedentary behaviour, and overweight/obesity; yet interventions targeting these groups are lacking. Considering the poorer health outcomes and lack of access to health services in these areas, greater emphasis should be placed on development, implementation and evaluation of interventions targeting older rural Australian adults exhibiting chronic disease risk factors.

Combined diet and physical activity interventions are considered to be the most effective for preventing and reversing MetS, individual parameters, and related chronic diseases; yet maintenance of diet and physical activity behaviour change is often difficult to achieve. This study aimed to determine the most effective behaviour change techniques and delivery modes for rural Australian adults *with* or *at risk* of MetS, and the effect on important health outcomes. The study also aimed to determine the most effective recruitment and retention strategies for the high risk target group.

Methods

This study was a 6-month randomised controlled trial (RCT) of a home-based physical activity and dietary behaviour change intervention for adults aged 50 to 69 years with or at risk of MetS, residing in rural Western Australia. Recruitment occurred in three stages and the procedure was staggered over a 14-month period from October 2013 to December 2014. Screening stage one involved 12,723 telephone calls to households in the region, which resulted in 1,134 participants attending a local clinic for screening stage two. A total of 486 participants were eligible for screening stage three, and randomisation occurred after MetS status was confirmed. A total of 401 participants were eligible for the study and randomised to intervention (n=201) or waitlisted control (n=200) group. The intervention group participants received printed and online materials designed to educate and motivate dietary and physical activity improvements using effective behaviour change techniques, based on the principles of Self-Determination Theory. Goal setting, self-monitoring, feedback and shaping knowledge

were incorporated into the home-based program, empowering participants to self-manage their health behaviours within their own environment. Motivational interviewing was implemented by trained research assistants via telephone over the six month intervention period.

Data were collected at baseline and six months post-test. Primary outcome measures consisted of self-reported dietary and physical activity behaviours using the Fat and Fibre Barometer and the International Physical Activity Questionnaire (Short Form). Secondary outcome measures comprised anthropometry (body mass index [BMI]; waist circumference), blood pressure, lipid profile (total-, HDL-, LDL-, non-HDL cholesterol; triglycerides), and fasting plasma glucose. MetS status was determined using the International Diabetes Federation criteria, and CVD risk was calculated using the Australian Absolute Cardiovascular Disease Risk Calculator. Process evaluation was also conducted to identify the appropriateness of the intervention to the target group, and assesses the appropriateness and effectiveness of the research procedure. Evaluation of program materials was conducted halfway through the intervention, and exit interviews were conducted post-intervention.

Results

At post-test, 151 (75.1%) intervention and 161 (80.5%) control group participants attended the clinic for data collection and were included in the anthropometric analysis; 151 intervention and 159 (79.5%) control group participants were included in the self-report analysis, and 130 (64.7%) intervention and 144 (72.0%) control group participants were included in the blood sample analysis after participants with incomplete data were removed from the sample. Upon completion of the study, the intervention group marginally increased their metabolic equivalent (MET) minutes of moderate intensity physical activity per week ($p=0.049$), and significantly improved fibre intake ($p<0.001$), fat intake ($p=0.003$), and vegetable serves per day ($p=0.002$) from baseline to post-test relative to the control group, after controlling for confounders. Significant improvements in triglyceride concentration (-0.10 mM, $p=0.002$), total cholesterol concentration (-0.09 mM, $p=0.02$), non-HDL cholesterol concentration (-0.08 mM, $p=0.02$), waist circumference (-2.11 cm, $p=0.03$), waist-to-hip ratio (-0.01, $p=0.04$), weight (-0.70 kg, $p=0.01$), and body mass index (-0.20 kg/m^2, $p<0.001$) were observed. Additionally, 15 less participants were classified *with* MetS and 8 less were classified as *at risk* of MetS at post-test, and a significant reduction in cardiovascular

risk score (-0.82, $p<0.001$) relative to the control group was observed for the intervention group relative to the control group.

After randomisation, 18% of participants withdrew from the intervention. The average number of motivational interview calls completed by participants who finished the six month intervention was three, with approximately one third (32%) completing between four to six calls. Most participants reported increased motivation for physical activity and dietary improvements due to the program resources, which they reported to be useful, attractive, and suitable to people their age. Suggestions to improve the program included face-to-face delivery mode, more regular feedback, and more incentives to complete the program.

Conclusion

The present study contributes to the knowledge for dietary and physical activity behaviour change interventions in rural Australia targeting adults at an increased risk of developing chronic disease. Identifying individuals both *with* and *at risk* of MetS allowed for primary and secondary prevention measures to be implemented and rigorously evaluated via a RCT. The findings indicate that it is worthwhile intervening at both levels to prevent/delay the onset of T2DM and CVD, and allows for a greater number of high risk individuals to be identified. The significant improvements in dietary and physical activity behaviour for the intervention group suggest that the combination of strategies and delivery modes is effective for changing many behaviours and health outcomes for the high risk group. The importance of health promotion, particularly primary prevention, to encourage and empower individuals to adopt and maintain healthy behaviours before the development of chronic disease should not be ignored. The difficulty of reversing T2DM and CVD in older age further highlights the need for greater primary prevention efforts, particularly in high risk groups and settings.

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needed access to improved chronic disease prevention services in rural and remote areas of Australia.

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List of publications as part of the thesis

The following publications are included as part of this thesis (copies available in Appendix A):

1. **Blackford, K.**, Jancey, J., Lee, A. H., James, A., Howat, P., Hills, A. P., & Anderson, A. S. (2014). A randomised controlled trial of a physical activity and nutrition program targeting middle-aged adults at risk of metabolic syndrome in a disadvantaged rural community. *BMC Public Health*, *15*, 284. http://dx.doi.org/10.1186/s12889-015-1613-9. [Impact Factor 2.26]
2. **Blackford, K**., Jancey, J., Lee, A. H., James, A., Howat, P., & Waddell, T. (2016). Effects of a home-based intervention on diet and physical activity behaviours for rural adults with or at risk of metabolic syndrome: a randomised controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, *13*, 13. http://dx.doi.org/10.1186/s12966-016-0337-2. [Impact Factor 4.11]
3. **Blackford, K**., Jancey, J., Lee, A. H. James, A., Waddell, T., & Howat, P. (2016). Home-based lifestyle intervention for rural adults improves metabolic syndrome parameters and cardiovascular risk factors: A randomised controlled trial. *Preventive Medicine, 16*(89), 15-22. http://dx.doi.org/10.1016/j.ypmed.2016.05.012. [Impact Factor 2.893]
4. **Blackford, K**., Lee, A. H., James, A., Waddell, T., Hills, A. P., Anderson, A. S., Howat, P., & Jancey, J. (2016). Process evaluation of the Albany Physical Activity and Nutrition (APAN) program, a home-based intervention for metabolic syndrome and associated chronic disease risk in rural Australian adults. *Health Promotion Journal of Australia* (Online Early). http://dx.doi.org/10.1071/HE16027 [Impact Factor 1.231]

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Statement of Contribution of Others

The Collaboration for Evidence, Research and Impact in Public Health within the School of Public Health at Curtin University (formerly the Western Australian Centre for Health Promotion Research) provided the research environment that supported the PhD Scholar to undertake this research. The PhD Scholar was the manager of the project and active in designing the methodology and intervention, undertaking recruitment, implementing the intervention program, and data collection and analysis. The PhD Scholar was responsible for writing all publications presented as part of the thesis, with input from co-authors. Details are provided below.

- **Associate Professor Jonine Jancey** contributed as PhD supervisor and provided close and ongoing support and involvement with the study. She participated in the study and intervention design, read drafts and suggested improvements for all four publications.
- **Professor Andy Lee** contributed as PhD co-supervisor and provided advice on statistical analysis for all four publications. He also participated in the study design, read drafts and suggested improvements for all four publications.
- **Dr Anthony James** contributed as PhD co-supervisor and provided advice on collection and analysis of blood samples. He also participated in the study design, read drafts and suggested improvements for all four publications.
- **Professor Peter Howat** contributed as PhD co-supervisor and provided ongoing support and involvement with the study. He participated in the study and intervention design, read drafts and suggested improvements for all four publications.
- **Professor Andrew Hills** contributed as a collaborator and participated in the study design, read drafts and suggested improvements for publications 1 & 4.
- **Professor Annie Anderson** contributed as a collaborator and participated in the study design, read drafts and suggested improvements for publications 1 & 4.
- **Mrs Tracy Waddell** provided assistance with recruitment and data collection, and provided motivational support to study participants. She read and approved drafts for publications 2-4.

Appendix C provides signed statements of the contribution of each co-author listed above.

List of Conference Presentations

1. Waddell, T., **Blackford, K**., Jancey, J., Howat, P., Lee, A., James, A. The Albany Physical Activity & Nutrition (APAN) Program, *Healthy Futures Forum*, Albany Western Australia, February 2015 (Oral Presentation).
2. **Blackford, K**., J. Jancey, A. H. Lee, A. James, P. Howat. A randomised controlled trial of an intervention targeting adults with metabolic syndrome in a rural community, *Population Health Congress*, Hobart Tasmania, October 2015 (Oral Presentation).
3. **Blackford, K**., J. Jancey, A. H. Lee, A. James, P. Howat. A low-cost, home-based intervention incorporating motivational interviewing can effectively improve dietary and physical activity behaviours of disadvantaged rural adults with or at risk of metabolic syndrome. *International Society of Behavioural Nutrition and Physical Activity (ISBNPA) 2016 Annual Meeting*, Cape Town South Africa, June 2016 (Oral Presentation).
4. **Blackford, K**., J. Jancey, A. H. Lee, A. James, P. Howat. Process evaluation of the Albany Physical Activity and Nutrition (APAN) program. *23rd National Conference of the Australian Health Promotion Association (AHPA)*, Perth Western Australia, June 2016 (Oral Presentation).
5. **Blackford, K**., J. Jancey, A. H. Lee, A. James, P. Howat. Home-based dietary and physical activity behaviour change intervention for rural older adults with and at risk of metabolic syndrome improves chronic disease risk factors. *Mark Liveris Student Seminar*, Perth Western Australia, September 2016 (Oral Presentation).

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List of Abbreviations

APAN	Albany Physical Activity & Nutrition
ATP III	Adult Treatment Panel III
AUSDRISK	Australian Type 2 Diabetes Risk Assessment
BMI	Body mass index
CATI	Computer-Assisted Telephone Interviewing
cm	Centimetre
CVD	Cardiovascular disease
g	Grams
GEE	Generalised estimating equations
HDL	High density lipoprotein
IDF	International Diabetes Federation
IPAQ	International Physical Activity Questionnaire
IPAQ-SF	International Physical Activity Questionnaire Short Form
kg	Kilogram
LDL	Low density lipoprotein
m	Metre
MET	Metabolic equivalent of task
MetS	Metabolic syndrome
mg/dL	Milligram per decilitre
min	Minute
mM	Millimolar

mmHg	Millimetres of mercury
O_2	Oxygen
p	Probability
RCT	Randomised controlled trial
SD	Standard deviation
SEIFA	Socioeconomic Indexes for Areas
SPSS	Statistical Package for the Social Sciences
T2DM	Type 2 diabetes mellitus
USA	United States of America
WA	Western Australia

Exegesis

1.0 Introduction

Metabolic syndrome (MetS) is a cluster of factors that significantly increase the risk of type 2 diabetes mellitus (T2DM), cardiovascular disease (CVD), and all-cause mortality (Kaur, 2014). The prevalence of MetS and associated chronic diseases are increasing globally (Chen, Magliano, & Zimmet, 2012; Kassi, Pervanidou, Kaltsas, & Chrousos, 2011; Murray & Lopez, 2013), due to the growing prevalence of overweight and obesity, physical inactivity, sedentary behaviour, and poor diet (Korczak, Dietl, & Steinhauser, 2011). These major risk factors are more prevalent in disadvantaged older adults who reside in rural areas of Australia (Australian Institute of Health and Welfare, 2014); a high risk population group who has less access to health services and higher morbidity and mortality rates than their metropolitan counterparts (Australian Bureau of Statistics, 2015).

Management of T2DM and CVD becomes difficult once developed, which highlights the need for early warning/screening systems to protect those at high risk (Sherwin & Jastreboff, 2012). Due to the amenable nature of many chronic diseases to lifestyle changes, both identification of high-risk populations and timely intervention are important preventive measures (Australian Institute of Health and Welfare, 2014). Identifying overweight/obese individuals *with* and *at risk* of MetS and implementing interventions is therefore a public health priority (Barazzoni, Silva, & Singer, 2013). Lifestyle interventions are generally more effective than pharmacological therapies at reversing MetS (Dunkley et al., 2012), and all of the clinical markers of MetS can be improved by interventions that promote the adoption of a healthy diet and increased levels of physical activity (Bassi et al., 2014); therefore weight loss via diet and physical activity modification is typically the focus of interventions (Mecca et al., 2012).

While it is generally acknowledged that diet and physical activity modifications are the most effective prevention and treatment of MetS, modifications are not always successfully administered (Kaur, 2014) due to interventions lacking effective behaviour change techniques. Interventions should therefore be designed to incorporate strategies to empower and motivate individuals, to ensure any changes are maintained beyond the duration of the intervention (Dunkley et al., 2012). Effective behaviour change

techniques for diet and physical activity improvements include goal setting, self-monitoring, follow-up and support, counselling, and regular feedback (Greaves et al., 2011). A number of studies have evaluated the effectiveness of such interventions for adults *with* and *at risk* of MetS and related chronic disease (Higgins & Green, 2011; Lin, Chiang, Tzeng, & Chiang, 2014), with findings indicating a need for further investigation into optimal delivery modes and intervention components for these high risk adults residing in rural areas.

Only a small number of diet and physical activity behaviour change studies have been conducted in rural areas for adults *with* or *at risk* of MetS and associated chronic diseases (Oh et al., 2008; Perri et al., 2008; Pullen, Hageman, Boeckner, Walker, & Oberdorfer, 2008; Stuckey et al., 2011; Vadheim et al., 2010; Weinstock, Trief, Cibula, Morin, & Delahanty, 2013). The findings suggest that further research in an Australian context is required, to determine the optimum delivery modes and strategies. Improving health outcomes via prevention and management of noncommunicable disease is a priority public health issue, which is increasingly challenging due to the ageing population and adoption of lifestyle behaviours that increase the risk of chronic disease (Australian Institute of Health and Welfare, 2014). Currently, there is a gap in knowledge of physical activity and dietary behaviour change interventions in a rural Australian setting targeting MetS and chronic disease risk in older adults. The Albany Physical Activity and Nutrition (APAN) intervention aimed to increase levels of physical activity, reduce sedentary behaviour and improve diet via innovative behaviour change techniques (Michie et al., 2015), in an effort to contribute to the prevention of chronic diseases associated with MetS and overweight/obesity in rural areas.

1.1 Research aims and objectives

The aim of this study was to develop, implement, and evaluate a home-based physical activity and dietary behaviour change intervention for adults aged 50 to 69 years *with* or *at risk* of MetS, residing in rural Western Australia (WA). To achieve this aim, the objectives were to:

1. Design and implement a randomised controlled trial (RCT) of a home-based intervention to improve the physical activity and dietary behaviours of adults aged 50-69 years *with* or *at risk* of MetS, residing in a rural community (**Publication 1**, Appendix A);

2. Determine the effectiveness of strategies to recruit and retain the target group in a physical activity and dietary behaviour change intervention (**Publication 4**, Appendix A);
3. Assess the acceptability and appropriateness of the intervention strategies and resources for the target group (**Publication 4**, Appendix A);
4. Assess at post-test the change in physical activity and dietary behaviours of intervention participants relative to the control group (**Publication 2**, Appendix A);
5. Assess at post-test the change in body composition, MetS parameters, and cardiovascular risk factors for the intervention group relative to the control group (**Publication 3**, Appendix A); and
6. Assess the change in MetS status and CVD risk scores post-intervention relative to the control group.

It was hypothesised that by the end of the study, the intervention group compared to the control group would show significant improvements in the following primary and secondary outcome measures:

<u>Primary outcome measures</u>

1. Self-reported physical activity behaviours:

- Minutes of moderate and vigorous intensity physical activity per week;
- Sitting time per week;
- Minutes of strength exercises per week; and
- Minutes of walking per week.

2. Self-reported dietary behaviours:

- Fat and fibre intake;
- Fat avoidance; and
- Daily serves of fruit and vegetables.

<u>Secondary outcome measures</u>

3. Anthropometry:

- Body Mass Index (BMI) (weight/height); and
- Waist circumference.

4. MetS parameters:

- Fasting glucose concentrations;
- Lipid profile (cholesterol and triglyceride);
- Blood pressure; and
- Waist circumference.

5. MetS status; and
6. CVD risk score.

1.2 Significance of the research

Building upon previous research, this study is the first trial of a home-based dietary and physical activity behaviour change intervention targeting older adults both *with* and *at risk* of MetS in a rural Australian setting. The significance of this research includes the following:

1. To address the obesity epidemic as a major cause of MetS and related chronic diseases, it is crucial to implement healthy lifestyle interventions with those at high risk of chronic disease, including middle aged and older adults in rural areas. Intervention activities actively promoted improvements in levels of physical activity, strength exercises, fruit and vegetable intake, and reductions in sitting time, fat intake, and sugar consumption. By doing this it aimed to contribute to the prevention of inter-related chronic diseases associated with overweight/obesity and MetS.
2. The home-based intervention incorporated effective behaviour change techniques, based on theories to motivate the individual rather than prescribing intervention components via coercion. Resources and strategies were designed for use in participants' homes to enhance autonomy and self-efficacy, and to maintain independent living. Rigorous process evaluation was conducted to enable recommendations for future interventions. Implementing the intervention in a rural community with no other health programs occurring for the target group provided the opportunity to expand the knowledge base for this type of intervention with minimal contamination.
3. Identifying individuals both *with* and *at risk* of MetS allowed for primary and secondary prevention measures to be implemented and rigorously evaluated via a RCT. The findings indicate that it is worthwhile intervening at both levels to

prevent/delay the onset of chronic disease, and allows for a greater number of high risk individuals to be identified.

4. This trial, targeting individuals *with* and *at risk* of MetS in a rural community, is timely and placed firmly within the national research priority area of "Promoting and Maintaining Good Health" to achieve the "Preventive Healthcare" goal. The study evaluated a practical home-based program which has led to successful Healthway funding for a translational project to be implemented within a rural primary care setting in 2016-2018. This has the potential for expansion into other rural areas in WA, and throughout Australia.

2.0 Literature review

2.1 Introduction

MetS is considered a major public health issue due to the associated risk of developing T2DM and CVD (Kassi et al., 2011), which contribute significantly to the burden of disease worldwide (Chen et al., 2012; Murray & Lopez, 2013). Global prevalence of MetS continues to increase due to the apparent rise in consumption of energy-dense, nutrient poor foods, adoption of sedentary lifestyles, and laying down of excess body fat (Kaur, 2014), particularly in disadvantaged groups and rural/remote older Australians (Australian Institute of Health and Welfare, 2014). The upward worldwide trend in MetS prevalence has resulted in the development of public health efforts to both treat and prevent the syndrome. It is generally accepted that addressing MetS as one entity through lifestyle interventions is more effective than pharmacological treatments that focus on individual parameters (Kaur, 2014). Given the increased prevalence of the major MetS risk factors (poor diet, physical inactivity, sedentary behaviour and overweight/obesity) and the associated impact on the burden of disease among older rural Australian adults (Australian Bureau of Statistics, 2015), determining the most effective prevention strategies for these vulnerable group is imperative.

2.2 Metabolic syndrome overview

2.2.1 Background

MetS has been around as a concept since the 1920s, when a link was established between hypertension, hyperglycaemia, and gout (Kylin, 1923). Decades later, the association between visceral fat and factors common to T2DM and CVD was described (Vague, 1947). In 1988 the term “Syndrome X” was developed as the name for a cluster of risk factors for T2DM and CVD (Reaven, 1988), which later became known as “metabolic syndrome” (Grundy, Brewer, Cleeman, Smith, & Lenfant, 2004). A number of criteria have been developed to define MetS (Kaur, 2014), with dyslipidaemia, hyperglycaemia, and hypertension being the most widely recognised metabolic risk factors (Grundy et al., 2005), which are present more commonly in overweight/obese individuals (Grundy, 2016).

2.2.2 Definition

MetS can be generally defined as “a constellation of interconnected physiological, biochemical, clinical, and metabolic factors that directly increases the risk of CVD, T2DM, and all-cause mortality” (Kaur, 2014). The National Cholesterol Education Program Adult Treatment Panel III (ATPIII) and the International Diabetes Federation (IDF) (2005) criteria are the most commonly used worldwide definitions for MetS (Kaur, 2014). The ATPIII definition requires any three of the following parameters for diagnosis: increased waist circumference (≥102 cm men or ≥88cm women); raised triglyceride concentration (≥1.7 mM); reduced high density lipoprotein (HDL) cholesterol concentration (<1.03 mM men or <1.29 mM women); raised blood pressure (≥130/≥85 mmHg); and raised fasting plasma glucose concentration (≥6.1 mM) (Han & Lean, 2006).

The IDF definition incorporates abdominal obesity as a prerequisite for MetS diagnosis (Kassi et al., 2011), which is a focus when aiming to prevent T2DM and CVD (Han & Lean, 2006). The minimum requirement is central obesity as measured by ethnicity specific waist circumference cut-off values (≥94 cm men or ≥80 cm women [Europids, Sub-Saharan Africans, Eastern Mediterranean, Middle East]; ≥90cm men or ≥80cm women [South Asians, Chinese, Japanese]); plus any two of: raised triglyceride concentration (≥1.7 mM, or treatment for this); reduced HDL-cholesterol concentration (<1.03 mM in males and <1.29 mM in females, or treatment for this); raised blood pressure (systolic ≥130 mmHg or diastolic ≥85 mmHg, or treatment of previously diagnosed hypertension); raised fasting plasma glucose concentration (≥5.6 mM) (Zimmet et al., 2005).

2.2.3 Epidemiology

Worldwide prevalence of MetS is estimated at 25% of all adults 18+ years old (International Diabetes Federation, 2006). Prevalence varies across regions according to the definition used to define the syndrome. For example, in 2008 the prevalence in Greece was calculated at 24.5% of adults according to the ATPIII criteria, whereas it was 43.4% according to the IDF criteria (Grundy, 2008). The prevalence for Chinese adults aged 50 to 85 years was 15.7% using the ATPIII criteria compared to 25.8% using the IDF criteria (Grundy, 2008). The Australian prevalence was estimated at 34.4% of males and 27.4% of females using the IDF criteria, and 24.4% of males and

19.9% of females using ATPIII in 2015 (O'Neill & O'Driscoll, 2015). Regardless of the definition used, an important observation is that prevalence increases as age and body weight increase (O'Neill & O'Driscoll, 2015).

2.2.4 Pathophysiology

MetS is constituted by an assemblage of metabolic factors that advance the development of inflammation and atherosclerosis (Grundy et al., 2004). These are abdominal obesity, insulin resistance, hypertension, and dyslipidaemia (O'Neill & O'Driscoll, 2015).

Abdominal obesity

Abdominal obesity, which is associated with greater metabolic risk than overall body weight, has been increasing steadily over time in many countries due to poor diet, physical inactivity and sedentary behaviour (Mozaffarian, 2016). It is defined as an excess accumulation of visceral fat, which is stored in the abdominal cavity around major organs, often leading to excess energy storage in the liver, skeletal muscles, and the heart (Despres & Lemieux, 2006). Abdominal obesity therefore increases the risk of metabolic factors that lead to T2DM and CVD (Grundy, 2012).

Excess free fatty acids and other adipokines are released from excess adipose tissue, which can lead to a proinflammatory and prothrombotic state, as well as insulin resistance, which can lead to hyperglycaemia (Grundy, 2012). Excess free fatty acids can also support the development of elevated triglycerides, which can lower HDL cholesterol (Grundy, 2012). In summary, excess abdominal fat leads to overall systemic inflammation (Kaur, 2014), which increases the presence of the other MetS parameters (hypertension, insulin resistance, dyslipidaemia) (Despres & Lemieux, 2006). This highlights the importance of abdominal obesity as a central component of MetS diagnosis. The preferred measure of abdominal obesity is waist circumference (Welborn, Dhaliwal, & Bennett, 2003), which is considered a more effective biomarker of cardiovascular and metabolic risk than BMI (Barazzoni et al., 2013). A waist circumference ≥94 cm for men and ≥80 cm for women indicates increased risk of chronic disease (Zimmet et al., 2005).

Insulin resistance

Insulin resistance is a “pathophysiological condition in which a normal insulin concentration does not adequately produce a normal insulin response in the peripheral target tissues” (Kaur, 2014). Free fatty acids, released as a result of excess abdominal fat, contribute to the development of insulin resistance (Prasad, Ryan, Celzo, & Stapleton, 2012). High plasma insulin concentration fails to bring plasma glucose concentration to a normal level (Han & Lean, 2006). Over time, this can lead to hyperglycaemia (Markku & Johanna, 2014) (fasting plasma glucose concentration ≥5.6mM) (Zimmet et al., 2005), and increased low density lipoprotein (LDL) cholesterol concentration, triglyceride concentration, and blood pressure (Grundy et al., 2004). Insulin resistance and hyperglycaemia are therefore strongly associated with other MetS parameters, particularly excess body weight (Grundy et al., 2004).

Hypertension

Hypertension, also known as high blood pressure, is defined by “the presence of a chronic elevation of systemic arterial pressure above a certain threshold value” which affects the function and structure of cardiac and vascular systems (Giles, Materson, Cohn, & Kostis, 2009). High blood pressure is strongly associated with CVD, renal disease, and mortality (Carretero & Oparil, 2000), and is often present in combination with other CVD risk factors such as overweight/obesity, advancing age, insulin resistance, and dyslipidaemia (Messerli, Williams, & Ritz). Hypertension is diagnosed by measuring systolic and diastolic blood pressure. Systolic pressure is generated by ventricular contraction, and diastolic pressure represents pressure in the arteries between heart beats (Messerli et al., 2007). Normal blood pressure is defined by systolic pressure lower than 130 mmHg and diastolic blood pressure lower than 85 mmHg; whereas hypertension is defined by systolic pressure of 140+ mmHg and diastolic pressure of 90+ mmHg (Carretero & Oparil, 2000).

Dyslipidaemia

Dyslipidaemia is the term used to describe lipid abnormalities such as elevated fasting triglyceride and LDL cholesterol, and low HDL cholesterol concentrations (Kaur, 2014). Reduced concentration of HDL cholesterol (<1.03 mM men or <1.29 mM women) is particularly concerning due to the role in reverse cholesterol transport and protection against atherosclerosis (Blaha et al., 2008). Increased triglyceride concentration (≥1.7 mM) is associated with increased CVD risk (Bays et al., 2013).

Excess free fatty acids, due to excess abdominal fat and its associated insulin resistance, increase the production of very low lipoprotein (VLDL) cholesterol in the liver and decrease the clearance of LDL cholesterol in the liver (Prasad et al., 2012). Additionally, HDL cholesterol is correlated inversely with insulin resistance (Blaha et al., 2008) and elevated fasting triglyceride is associated with a low concentration of HDL cholesterol and high concentrations of LDL cholesterol (Ebbert & Jensen, 2013). There is sufficient evidence to suggest that higher concentration of HDL cholesterol is associated with reduced CVD risk (Ebbert & Jensen, 2013).

2.2.5 Cost of metabolic syndrome

As stated previously, the presence of MetS significantly increases the risk of developing T2DM and CVD (Blaha et al., 2008). Other systemic effects of MetS include chronic kidney disease, cirrhosis, non-alcoholic fatty liver disease, nondiabetic retinopathy, obstructive sleep apnoea, polycystic ovarian syndrome, and several cancers (Kaur, 2014).

Type 2 diabetes mellitus

The presence of MetS is a highly effective predictor of new cases of diabetes (Grundy et al., 2004). Over the past three decades, the prevalence of diabetes has more than doubled globally, with T2DM accounting for 90% of cases (Chen et al., 2012). By 2030, it is estimated that approximately 8% of the world's adult population will have diabetes, which represents 439 million people (Chen et al., 2012). The Australian prevalence in 2013 was 10%, which is estimated to increase to 11.3% by 2030 (Guariguata et al., 2014). The increasing trend is driven by the ageing population, as well as change in lifestyle leading to obesity and MetS (Guariguata et al., 2014).

The systemic inflammatory markers associated with MetS are useful for predicting the development of T2DM (Esser, Legrand-Poels, Piette, Scheen, & Paquot, 2014). MetS is considered a pre-diabetic state due to a five-fold increase in the risk of developing T2DM (Grundy, 2012). Primary characteristics of T2DM include insulin resistance in the skeletal muscle, liver, and adipose tissue, which results from chronic hyperglycaemia (Esser et al., 2014). Microvascular complications arising from T2DM include retinopathy, neuropathy, and nephropathy (Stolar, 2010). Macrovascular complications include coronary heart disease, stroke, myocardial infarction, and cataracts (Stolar, 2010).

Cardiovascular disease

CVD is the group of diseases which causes the highest number of deaths in Australia (Australian Institute of Health and Welfare, 2014). The leading cause of death in this group is ischaemic heart disease, which accounted for one in seven male deaths and one in eight female deaths in 2014 (Australian Bureau of Statistics, 2016). Individuals with MetS are characterised by increased platelet aggregation, which increases the risk of blood clotting (Blaha et al., 2008). The risk of ischaemic heart disease, myocardial infarction, and stroke is also increased significantly (Kaur, 2014). Individuals with MetS have three times the risk of CVD, and twice the associated mortality risk (Zimmet et al., 2005).

It is recommended that individuals have their CVD risk calculated using a traditional scoring tool after MetS diagnosis (Blaha et al., 2008). The presence of MetS is a reliable indicator of long-term CVD risk due to the risk of atherothrombotic complications; whereas classic equations such as Framingham are more useful indicators of short-term risk due to the inclusion of demographics and smoking behaviour in the algorithm (Kaur, 2014). However, the latter does not account for the impact of excess body fat, particularly abdominal adiposity; therefore identifying and addressing individuals with MetS can assist with CVD prevention (Han & Lean, 2006).

2.3 Metabolic syndrome risk factors

Several risk factors are responsible for the majority of MetS cases and CVDs in developed countries, including Australia (Korczak et al., 2011). These include physical inactivity, sedentary behaviour, poor diet, and overweight/obesity (Korczak et al., 2011). Understanding these risk factors can assist with determining prevention and management strategies to delay the progression to T2DM and CVD (Edwardson et al., 2012).

2.3.1 Physical activity

Physical activity is defined as “any bodily movement produced by skeletal muscles that expends energy” which includes movement in a number of domains such as occupation, leisure, and transport (W. Brown, Bauman, Bull, & Burton, 2012). Individuals who are physically active have a reduced risk of premature death, cardiovascular-related death, CVD, hypertension, T2DM, MetS, some cancers (specifically breast and colon),

osteoporosis, and fall-related injury; and improved psychological wellbeing via reduced stress, anxiety and depression (I. Lee et al., 2012; Myers et al., 2015; Warburton, Nicol, & Bredin, 2006). Additionally, there is strong evidence for improved bone health, cognitive function, and functional health (I. Lee et al., 2012). Physical activity is also a key component of energy balance, which determines body weight and weight-related health complications (World Health Organization, 2010).

Measurement of physical activity

There are several methods for classifying and measuring physical activity. Activity can be classified according to the type (aerobic, strength, flexibility, and balance) and intensity (sedentary, light, moderate, vigorous) (World Health Organization, 2010). The energy expended by these activities can be quantified by determining the metabolic equivalents (METs) (Jette, Sidney, & Blumchen, 1990). A MET can be defined as "the amount of energy consumed at rest, sitting quietly in a chair, approximately 3.5 mL O_2/kg/min" (Jette et al., 1990). Expenditure at two METs therefore requires double the resting metabolism, and four METs requires quadruple the resting metabolism. Different activities have different energy costs according to their MET values. Light intensity activities such as standing and light housework expend 1.6 to 2.9 METs; moderate intensity activities such as gardening, heavy housework, brisk walking and social tennis expend 3.0 to 5.9 METs; and vigorous intensity activities such as cycling, jogging, rowing, and competitive sports expend ≥ 6 METs (W. Brown et al., 2012; Jette et al., 1990). Sedentary activities expend <1.5 METs, and can include sitting and lying during leisure (such as reading and watching television), occupation (such as desk work), and transport (such as driving or sitting in a train) (W. Brown et al., 2012).

There are various methods available for measuring physical activity. Indirect methods include self-report questionnaires, and direct methods traditionally include calorimetry, observation, and motion sensors such as accelerometers (Tudor-Locke & Myers, 2001). Accelerometers are small devices that can be worn on the hip or wrist, and have the capability of measuring duration and intensity of an individual's activity based on recorded motion (Butte, Ekelund, & Westerterp, 2012). Accelerometers can provide more objective measures of physical activity intensity; however, they are unable to distinguish between different activity types of the same MET category (Butte et al., 2012). They are also unable to provide context on the type of activity or the location in

which it is performed (Haskell, 2012). They also need to be worn during waking hours for five to seven days and rely on participant compliance.

Historically, self-report methods have provided an alternative to objective measures which are often impractical in a range of settings (Haskell, 2012). At a population level, questionnaires are more feasible than other methods due to their lower cost and respondent burden (Scholes, Bridges, Ng Fat, & Mindell, 2016). A number of self-report instruments have been developed, and many are able to accurately document the duration and type of activities, as well as intensity levels (Haskell, 2012). The International Physical Activity Questionnaire (IPAQ) is an example of a self-report instrument that was developed as a means of assessing population level physical activity (Craig et al., 2003). The instrument has been tested for validity and reliability in 12 countries, and the findings demonstrate acceptable measurement of physical activity duration, intensity, and type (Craig et al., 2003). The IPAQ is therefore suitable for large population-based studies.

Physical activity recommendations

Because skeletal muscle is the most sensitive tissue to insulin, physical activity is one of the most important and effective strategies for addressing insulin resistance (Alshehri, 2010). The impact of physical activity on the lipid concentration in skeletal muscle and overall insulin resistance is evident regardless of BMI (Alshehri, 2010). Combining strength and aerobic training is recommended for individuals with MetS, with particular emphasis on fast walking and jogging (moderate to vigorous intensity) (Laursen, Kristiansen, Marott, Schnohr, & Prescott, 2012) and reducing sedentary time (Bankoski et al., 2011). Australia's Physical Activity and Sedentary Behaviour Guidelines (Department of Health, 2014) align with the general recommendations for addressing MetS and reducing risk.

Australia's Physical Activity and Sedentary Behaviour Guidelines comprise recommendations for different age groups, based on current evidence (Department of Health, 2014). The physical activity guidelines for adults aged 18 to 64 years are outlined below (W. Brown et al., 2012).

- Doing any physical activity is better than doing none. If an individual currently does no physical activity, they should start by doing some, and gradually build up to the recommended amount.

- Adults should be active on most, preferably all, days every week.
- Adults should accumulate 150 to 300 minutes (2 ½ to 5 hours) of moderate intensity physical activity or 75 to 150 minutes (1 ¼ to 2 ½ hours) of vigorous intensity physical activity, or an equivalent combination of both moderate and vigorous activities, each week.
- Adults should do muscle strengthening activities on at least two days each week.

The guidelines for adults aged 65+ years encourage participation in a range of activities and are less prescriptive. The full guidelines state that older people:

- should do some form of physical activity, no matter what their age, weight, health problems or abilities;
- should be active every day in as many ways as possible, doing a range of physical activities that incorporate fitness, strength, balance and flexibility;
- should accumulate at least 30 minutes of moderate intensity physical activity on most, preferably all, days;
- who have stopped physical activity, or who are starting a new physical activity, should start at a level that is easily manageable and gradually build up the recommended amount, type and frequency of activity; and
- who continue to enjoy a lifetime of vigorous physical activity should carry on doing so in a manner suited to their capability into later life, provided recommended safety procedures and guidelines are adhered to (Sims et al., 2006).

The World Health Organization (2010) recommends a gradual approach to higher intensity levels of physical activity for all age groups to minimise the risk of injury.

Physical activity patterns

Urbanisation, globalisation, and an ageing population are three major factors responsible for the environments and behaviours that are contributing to high levels of physical inactivity in Australia and globally (World Health Organization, 2010). In 2014-15, approximately 30% of Australian adults were insufficiently active (<150 minutes per week) and 15% were inactive (Australian Bureau of Statistics, 2015). An individual is considered physically inactive when their activity level does not meet the current physical activity guidelines (I. Lee et al.). During the same period, 24% of adults reported at least two days of strength training per week (Australian Bureau of Statistics, 2015). Participation in different types of physical activity decrease as age increases,

with 45% of adults aged 65+ reporting no days where they achieved at least 30 minutes of physical activity (Australian Bureau of Statistics, 2015). Additionally, adults with MetS are more likely than healthy adults to be sedentary and less likely to be physically active (Rao, Orpana, & Krewski, 2016).

Cost of physical inactivity

Physical inactivity is the fourth highest mortality risk factor globally (6% of all deaths), behind high blood pressure (13%), tobacco use (9%), and high blood glucose (6%) (World Health Organization, 2010). It is estimated to be responsible for six to 10% of coronary heart disease, T2DM, breast cancer and colon cancer prevalence globally (I. Lee et al., 2012). Additionally, there is an inverse relationship between leisure-time physical activity and MetS (Vaughan et al., 2009), highlighting the importance of physical activity in the prevention of MetS.

2.3.2 Sedentary behaviour

Sedentary behaviour is defined as “activities that do not increase energy expenditure substantially above the resting level and includes activities such as sleeping, sitting, lying down, watching television, and other forms of screen-based entertainment” (Pate, O'Neill, & Lobelo, 2008). It is important to note that being sedentary is not the same as the absence of physical activity, or inactivity (Pate et al., 2008). The Australian sedentary behaviour guidelines for 18 to 64 year olds aim to minimise the amount of time spent in prolonged sitting; and break up long periods of sitting as often as possible (W. Brown et al., 2012).

Measuring sedentary behaviour

Sedentary activities are those which expend 1.0 to 1.5 METs (Pate et al., 2008). Measurement methods are similar to those used for the measurement of physical activity, and include both subjective and objective measures (Atkin et al., 2012). The limitation of accelerometers for measuring sedentary behaviour is that they quantify intensity levels well, but are unable to accurately distinguish between different sitting postures and standing (Atkin et al., 2012). Posture monitors such as ActivPALS (Spinney et al., 2015) are more accurate for detecting sitting behaviour; however, the limitation of using these devices in lieu of other activity monitors such as accelerometers is that they are unable to determine behaviour types and intensities (Atkin et al., 2012). Self-report instruments also exhibit limitations for measuring

sedentary behaviour. Many questionnaires are not able to measure sedentary behaviour with the same accuracy that they measure physical activity (Haskell, 2012). Additionally, self-reported sedentary behaviour is often limited by the difficulty of recall due to the intermittent nature of such activities (Atkin et al., 2012). However, the IPAQ has demonstrated fair to moderate agreement with objective measures of sitting for a number of population groups (Craig et al., 2003) and is therefore a suitable self-report instrument for measuring sedentary behaviour in large groups.

Cost of sedentary behaviour

On average, Australian adults spend 39 hours per week engaging in sedentary activity, and depending on occupation, can spend at least three quarters of their day sitting (Australian Bureau of Statistics, 2013b). Strong evidence exists for the association of sedentary time with T2DM and CVD, as well as all-cause and CVD-related mortality (Proper, Singh, van Mechelen, & Chinapaw, 2011; Wilmot et al., 2012). Additionally, longer periods of sedentary behaviour increase the risk of developing MetS (Edwardson et al., 2012). These associations are independent of physical activity, suggesting that long bouts of sedentary behaviour are not balanced by increased levels of physical activity; they are separate and distinct behaviours with their own health risks (Wilmot et al., 2012). Minimising sedentary behaviour is therefore an important target in MetS prevention.

2.3.3 Diet

Nutrition research has traditionally focused on nutrients in isolation, even though individuals do not eat nutrients in isolation (Cespedes & Hu, 2015). Dietary pattern analysis is therefore important for understanding an individual's diet as a whole, as well as understanding food groups, their combined nutrients, and their overall impact on health (Cespedes & Hu, 2015). Dietary patterns are defined as the overall combination of foods consumed by an individual habitually, which produce overall collective health benefits (Mozaffarian, 2016).

Measurement of diet

Measuring diet and dietary patterns can be challenging. Direct observation of free-living individuals is difficult, so there is typically a reliance on self-reported measures (Kirkpatrick et al., 2014). Self-report instruments commonly used in nutrition research include 24-hour recall, food record/diary, dietary history, food frequency questionnaire,

and screeners which incorporate questions to assess behaviour (Kirkpatrick et al., 2014). Each instrument type has strengths and limitations. The instruments that are capable of collecting detailed intake data are resource-intensive, expensive, and time-consuming, because they require a trained interviewer to administer (24-hour recall and dietary history) and are therefore not suitable for large studies (Shim, Oh, & Kim, 2014). Self-administered surveys such as dietary records and food frequency questionnaires are more suitable for large epidemiological studies, yet impose a relatively large respondent burden. They also assess usual intake rather than actual intake, and are subject to recall bias (Shim et al., 2014). Screeners, or food behaviour questionnaires, are useful in situations where rigorous assessment of dietary intake is impractical. The Fat and Fibre Barometer is an example of a food behaviour questionnaire that was designed to be self-administered relatively quickly and cost-effectively (Wright & Scott, 2000). The valid and reliable tool provides information on individuals and groups who may have higher fat and/or lower fibre intake patterns, and is suitable for use in dietary education and counselling programs.

Dietary guidelines and recommendations

The evidence for diet modifications in the prevention and treatment of individual MetS parameters is well-established, although there is no single diet recommended (Alshehri, 2010). Interventions for hypertensive and normotensive adults suggest that a population-based approach to reduced salt intake will reduce the risk of stroke, coronary heart disease, and overall CVD risk (Aburto et al., 2013; He, Li, & MacGregor, 2013). A systematic review and meta-analysis of RCTs examining the effect of dietary sugar on blood pressure and lipids found that increased sugar consumption increases blood pressure and influences serum lipids, independent of body weight (Te Morenga, Howatson, Jones, & Mann, 2014). The Mediterranean Diet promotes a high intake of fruit and vegetables, legumes, nuts and seeds, grains and cereals, and moderate-to-low consumption of dairy and meat products. A systematic review of trials investigating the effects of the diet found that adherence decreases inflammation and reduces the risk of mortality and CVD (Schwingshackl & Hoffmann, 2014). Based on these studies and a review of the evidence for beneficial dietary patterns for MetS (Calton, James, Pannu, & Soares, 2014), reduced intake of sodium, salt and saturated fat, and an increased consumption of fruit, vegetables, wholegrains, omega-3 fatty acids and dairy is recommended for prevention and treatment of individual MetS parameters and associated chronic diseases. These recommendations align with the Australian Dietary

Guidelines (National Health and Medical Research Council, 2013a), and as suggested by Ahluwalia et al. (2013) adhering to national dietary guidelines should reduce inflammation and incidence of MetS.

The Australian Dietary Guidelines provide information on quantities and types of foods to be consumed for health and wellbeing, based on scientific evidence (National Health and Medical Research Council, 2013a). The general guidelines encourage consumption of a wide variety of foods from the five food groups, and encourage reduced intake of saturated fat, added salt, added sugar and alcohol. A summary of the full guidelines is provided below (National Health and Medical Research Council, 2013a).

- To achieve and maintain a healthy weight, individuals should be physically active and choose amounts of nutritious food and drinks to meet energy needs;
- Enjoy a wide variety of nutritious foods from these five food groups every day:
  - Plenty of vegetables of different types and colours, and legumes/beans;
  - Fruit;
  - Grain (cereal) foods, mostly wholegrain and/or high cereal fibre varieties, such as breads, cereals, rice, pasta, noodles, polenta, couscous, oats, quinoa and barley;
  - Lean meats and poultry, fish, eggs, tofu, nuts and seeds, and legumes/beans;
  - Milk, yoghurt, cheese and/or their alternatives, mostly reduced fat; and
- Drink plenty of water.
- Limit intake of foods containing saturated fat, added salt, added sugars and alcohol;
- Encourage, support and promote breastfeeding; and
- Care for food; prepare and store it safely.

The recommended quantities of each food group are provided according to serve numbers, which vary depending on sex and age group. For example, males generally require more serves of some food groups than females due to greater energy needs (National Health and Medical Research Council, 2013a).

Cost of poor dietary patterns

Several cardiometabolic risk factors are influenced by poor dietary habits, including hypertension, inflammation, oxidative stress, visceral fat, LDL cholesterol, and obesity (Mozaffarian, 2016). Increased consumption of refined, low-quality carbohydrates appears to displace or reduce consumption of healthful foods such as fruit, vegetables,

nuts and legumes (Mozaffarian, 2016), and is associated with insulin resistance, MetS, and T2DM (Blaha et al., 2008). Diets that are high in saturated fat, low in fibre content, and energy dense are longitudinally associated with cardiometabolic risk factors, particularly in obese individuals (Johns et al., 2015). Recommended dietary patterns for the prevention of MetS, associated chronic diseases, and general good health include less processed foods such as fruits, vegetables, nuts, seeds, wholegrains, legumes, and unsaturated vegetable oils; less red and processed meats; and less added and refined sugar (Mozaffarian, 2016). In 2014-15, 50% of Australian adults did not meet the guidelines for fruit intake, and 93% did not meet the guidelines for vegetable intake (Australian Bureau of Statistics, 2015). The proportion of adults meeting both guidelines was just 5% of the population (Australian Bureau of Statistics, 2015).

2.3.4 Overweight/obesity

Obesity is defined as "the disease in which excess body fat has accumulated to such an extent that health may be adversely affected" (World Health Organization, 2000), and is strongly associated with all metabolic risk factors, highlighting the link between excess weight and MetS (Grundy, 2016). Obesity supplies excess fat to muscles and the liver, as well as other organs and tissues, which is strongly associated with insulin resistance and other metabolic abnormalities (Grundy, 2016).

Measurement of overweight/obesity

BMI is the most useful measure of obesity at a population level (World Health Organization, 2000). BMI is calculated as weight in kilograms divided by the square of the height in metres (kg/m^2) (World Health Organization, 2000). Individuals are classified according to the following guidelines: underweight (BMI < 18.50); normal weight (BMI 18.50 – 24.99); overweight (BMI 25.00 – 29.99); and obese (BMI ≥ 30.00) (World Health Organization, 2000). As BMI increases, the risk of comorbidities increases. Waist circumference is another measure of overweight/obesity, which addresses the issue of BMI not accounting for variations in the distribution of body fat (World Health Organization, 2000). A waist circumference above 80cm for females and 94cm for males is considered to elevate the risk of CVD (Han & Lean, 2006). Waist circumference serves as the first screening component for MetS when using the IDF criteria, providing a simple and low-cost screening process that can be performed in any location (Zimmet et al., 2005). The IDF criteria accounts for the association between

abdominal obesity and all other components of MetS, by using increased waist circumference as the necessary component for diagnosis (Zimmet et al., 2005).

Epidemiology

The global prevalence of overweight and obesity has increased substantially over the past 30 years (Ng et al., 2014). Between 1980 and 2008, the global prevalence of male obesity increased from 4.8% to 9.8% and the female prevalence increased from 7.9% to 13.8% (Malik, Willett, & Hu, 2013). Almost two thirds of Australian adults are overweight or obese (63%) which has increased from 56% in 1995 (Australian Bureau of Statistics, 2015). Additionally, approximately 77% of males and 81% of females aged 55+ years have a waist circumference that places them at an increased risk of developing chronic disease (Australian Bureau of Statistics, 2015). These upward trends are predicted to in Australia and globally (Ng et al., 2014).

Cost of overweight/obesity

Overweight and obesity are associated with a number of comorbidities, including T2DM, hypertension, dyslipidaemia, CVD (specifically coronary artery disease, heart failure, atrial fibrillation), cerebrovascular disease, respiratory disease, gastrointestinal complications, osteoarthritis, chronic kidney disease, several cancers, and MetS (Guh et al., 2009; Han & Lean, 2006; Malnick & Knobler, 2006). Obesity is also associated with lower quality of life and psychosocial issues (Dixon, 2010).

2.4 Populations at increased risk of metabolic syndrome

2.4.1 Middle-age and older adults

The prevalence of overweight and obesity in older Australians is now 75% (Australian Bureau of Statistics, 2011). As obesity is a strong risk factor for chronic diseases such as T2DM and CVD, it is not surprising that the significant increase in the prevalence of T2DM and CVD is age related (Australian Bureau of Statistics, 2013a). Additionally, advancing age is a major contributor to all MetS parameters (Grundy et al., 2004; Han & Lean, 2006), leading to the prevalence of MetS increasing with age (Hildrum, Mykletun, Hole, Midthjell, & Dahl, 2007). In particular, the incidence rises rapidly in those of middle-age (Mecca et al., 2012). The relative risk for CVD in men, and T2DM in middle-aged adults is therefore increased for those with MetS (Wilson, D'Agostino,

Parise, Sullivan, & Meigs, 2005). Additionally, the proportion of the total Australian population aged 65+ years has increased from 11.8% in 1994 to 14.7% in 2014 (Australian Bureau of Statistics, 2014). Considering the ageing population and increased prevalence of major risk factors, middle-age and older adults are considered a high risk population group for MetS due to the potential associated burden of disease.

2.4.2 Rural and disadvantaged areas

Australian residential areas can be classified according to their population size. A metropolitan zone has an urban centre population of ≥ 100,000; a large rural zone has an urban centre population of 25,000 to 99,999; a small rural zone has an urban centre population of 10,000 to 24,999; and smaller populations are classified as remote zones (Australian Institute of Health and Welfare, 2004). In rural and remote areas, there is less access to health services, greater distances to travel for medical attention, and higher overall morbidity and mortality rates than metropolitan areas (Australian Institute of Health and Welfare, 2014). Overweight and obesity prevalence varies by remoteness, with 69% of adults in outer regional and remote areas classified as overweight or obese compared with 61% of adults who live in major cities (Australian Bureau of Statistics, 2015). Prevalence of waist circumference above the cut-off values of 94cm for men and 80cm for women is higher in outer regional and remote areas of Australia compared to major cities (68% of males and 72% of females versus 56% of males and 63% of females) (Australian Bureau of Statistics, 2015). Hypertension (E. Janus et al., 2008) and cholesterol concentrations are higher in rural areas compared to metropolitan areas of Australia (E. Janus et al., 2010). Additionally, older people are more likely to live outside major cities, with 16% of the population outside major cities being 65+ years of age compared with 13% in major cities in 2011-12 (Australian Institute of Health and Welfare, 2014).

Areas can also be classified according to advantage and disadvantage. The Socio-Economic Indexes for Areas (SEIFA) provides a rank of Australian areas based on relative socioeconomic advantage or disadvantage, using area-level indicators such as socioeconomic position, access to resources (material and social), social exclusion, social capital, and poverty (Pink, 2011). Areas that receive a score less than the national average (<1000) reveal an indicator of disadvantage that is greater than the national average, suggesting relative disadvantage (Pink, 2011). These areas have poorer health outcomes than more advantaged areas (Australian Institute of Health and Welfare,

2014). Structural and economic barriers to behaviour change may be greater for disadvantaged population groups (Ding, Do, Schmidt, & Bauman, 2015). Consequently, the gap between socioeconomic status groups for health risk behaviours is widening in Australia, particularly for fruit and vegetable intake (Ding et al., 2015). This may be due to the cost of a healthy basket of food being approximately 30% higher in rural and disadvantaged groups areas (Australian Institute of Health and Welfare, 2012). Adults in the least disadvantaged group are 1.5 times more likely to be sufficiently active than the most disadvantaged groups (Australian Bureau of Statistics, 2013b). Obesity prevalence increases in the most disadvantaged areas compared to the least disadvantaged areas (61% of males and 69% of females versus 55% of males and 60% of females) (Australian Bureau of Statistics, 2015). Individuals in these areas are also more likely than those in less disadvantaged areas to develop abnormal glucose metabolism, which is a risk factor for T2DM and CVD (E. Williams et al., 2012).

In both rural and disadvantaged areas, the prevalence of MetS, overweight/obesity, and related chronic disease is high and needs to be addressed to ensure better health outcomes into older age (E. Janus et al., 2007). This suggests that both rural and disadvantaged areas with high concentrations of older adults will require more targeted services in future years (Australian Institute of Health and Welfare, 2014). Addressing MetS and related risk factors is therefore imperative for the prevention of T2DM and CVD among these high risk groups.

2.5 Addressing metabolic syndrome

Traditional methods for addressing MetS include prevention and treatment strategies. Disease prevention is the term used to describe a range of strategies that aim to reduce risk factors or increase protective factors for a particular health issue or disease (Nutbeam, 1986). For example, interventions to reduce poor diet, physical inactivity and overweight/obesity aim to prevent MetS and associated chronic diseases. Treatment strategies that include drug therapy are recommended only when lifestyle measures fail to improve individual MetS parameters; however, many physicians believe that it is easier to administer pharmacological treatment to treat individual MetS parameters than to address the syndrome as one entity with lifestyle improvement (Kaur, 2014). The latter relies on improvements in individual behaviour change, and while this would provide a longer-term solution and address all MetS risk factors, the strategy is not always successfully administered (Kaur, 2014). While medications may be warranted

for certain conditions when lifestyle change is not enough, the importance of prevention via healthy lifestyle and reduced risk factors for MetS should not be overlooked (Binns, Howat, Smith, & Jancey, 2016).

A systematic review and meta-analysis of weight maintenance RCTs was conducted to evaluate the effectiveness of non-surgical interventions on weight loss maintenance (Dombrowski, Knittle, Avenell, Araújo-Soares, & Sniehotta, 2014). Intervention types included lifestyle, pharmacological, or food replacement, with a primary short term outcome of weight loss at 12 months, and long term aim of preventing associated chronic diseases. The interventions which focused on diet or physical activity alone were not found to be effective. Many of these studies followed a regimen (prescribed components) which can be unrealistic for long-term maintenance (Dombrowski et al., 2014). A systematic review of RCT interventions for MetS evaluated the impact of lifestyle, drug therapy, and surgery (Dunkley et al., 2012). The findings suggested that lifestyle interventions that incorporated diet and physical activity to maintain weight were the most effective for reversing MetS and reducing the risk of T2DM and CVD; however, the optimal intervention components and delivery mode were unclear, due to the differences in intervention designs that were included in the review (Dunkley et al., 2012). Considering this, carefully designed health promotion interventions for the prevention of MetS and related chronic disease for high risk population groups are vital.

Comprehensive applied health promotion increases the ability of individuals to increase control over the determinants of health, by altering the social, environmental, economic conditions in which they live (Binns et al., 2016; Nutbeam, 1998). The focus is typically on primary and secondary prevention, rather than tertiary prevention (treatment). Given the link between MetS, T2DM and CVD, both primary and secondary prevention of MetS and its components can delay the progression to these chronic diseases. Primary prevention refers to strategies that aim to prevent the initial occurrence of a health issue or disease, whereas secondary prevention refers to strategies that enable early detection and treatment of a health issue or disease, to prevent progression (Nutbeam, 1998). As Kaur (2014) and Dunkley et al. (2012) highlight, improving lifestyle in lieu of drug therapy is key to addressing MetS, provided it is administered effectively. Interventions can aim to change behaviours and aim to change health outcomes (Courneya, 2010). The primary outcome of behaviour change intervention trials is a certain aspect of behaviour (for example, physical activity behaviour can include type, duration or

intensity); whereas the primary outcome of effectiveness trials is a certain health outcome (such as incidence and biomarkers) (Courneya, 2010).

The following section provides a summary of primary and secondary prevention interventions that aim to change health outcomes associated with MetS, followed by a summary of behaviour change interventions that aim to address the major behavioural risk factors for MetS. Interventions for rural populations will also be explored.

2.5.1 Primary prevention

In the context of MetS, primary prevention includes interventions to address the major risk factors such as poor diet, physical inactivity, sedentary behaviour, and overweight/obesity. These interventions target individuals who may be at risk but not yet diagnosed with MetS. Studies outlined in this section report on the effectiveness of combined diet and physical activity and overweight/obesity interventions and their impact on health outcomes. Participants include adults who have one of the following conditions which increase the risk of MetS, T2DM and CVD: impaired glucose tolerance, central obesity, dyslipidaemia, hypertension, or overweight/obesity.

Numerous trials have been conducted globally that demonstrate the effectiveness of increased physical activity and improved diet on the incidence of diabetes for high risk individuals. The first RCT to demonstrate a significant reduction in diabetes incidence for adults with impaired glucose tolerance was the Da Qing study in 1986 (Pan et al., 1997). Chinese adults were screened for impaired glucose tolerance and randomised to diet intervention group (n=130), exercise intervention group (n=141), diet plus exercise intervention group (n=126), or control group (n=133). The intervention components consisted of recommended modifications to diet and/or exercise. Incidence of diabetes at six years was 43.8% in the diet group, 41.1% in the exercise group, 46.0% in the diet plus exercise group, and 67.7% for the control group (Pan et al., 1997), which persisted for 20 years post-intervention (Li et al., 2008). The study incorporated some counselling for the intervention groups; however, this is not well described or evaluated. The underlying behaviour change mechanisms responsible for the reduction in diabetes incidence is therefore unclear. It is also difficult to extrapolate these findings to other ethnic and socioeconomic groups.

The Finnish Diabetes Prevention Study evaluated the effectiveness of lifestyle intervention for individuals at high risk of developing T2DM (Tuomilehto et al., 2001).

Participants (n=522) from Finland were middle-aged (mean age 55 years) and overweight (mean BMI 31), with impaired glucose tolerance. Intervention group participants received detailed, tailored dietary advice via several one-on-one sessions with a nutritionist, and the physical activity component consisted of supervised strength training and recommendations for endurance training. The control group participants received oral and basic written information only. Follow-up measurements after four years demonstrated a significant difference between groups for the risk of diabetes and the incidence of diabetes (11% for the intervention group versus 23% for the control group), which was directly associated with lifestyle changes (Tuomilehto et al., 2001). Long-term follow-up (13 years) of the participants indicated that the intensity of the intervention can be beneficial for delaying the onset of chronic disease (J. Lindström et al., 2013); however, this style of intervention may not be practical in some areas with limited access to services and resources, due to the face-to-face delivery mode that was implemented.

Numerous studies have been conducted since the Da Qing study and Finnish Diabetes Prevention study. A systematic review of RCTs of lifestyle intervention for adults with impaired glucose intolerance was conducted, with diabetes incidence as the primary outcome (Yoon, Kwok, & Magkidis, 2013). Across seven trials, which produced 25 publications, the authors concluded that lifestyle interventions can significantly reduce diabetes incidence (4% to 21.7%) for individuals with impaired glucose tolerance. The change in lifestyle was not maintained for any of the studies after completion of the intervention period, resulting in no long-term mortality or morbidity benefits (Yoon et al., 2013). The authors suggested that future interventions targeting chronic disease risk should incorporate behavioural components to ensure the health outcomes are maintained in the long-term. Another systematic review of lifestyle interventions for adults with and at risk of T2DM evaluated the effectiveness of delaying progression to diabetes or associated chronic diseases (including CVD) (Schellenberg, Dryden, Vandermeer, Ha, & Korownyk, 2013). Of the 20 studies included in the systematic review, nine targeted adults at an increased risk of T2DM, which demonstrated moderate-strength evidence that chronic disease risk can be reduced via comprehensive lifestyle intervention. Such interventions included a combination of exercise and dietary components, plus one other component (such as counselling, behaviour modification, or smoking cessation). The additional component was variable across the studies, limiting the authors' ability to comment on the most effective additional method when

implemented in combination with diet and physical activity modifications. The effectiveness of these methods needs to be further explored.

2.5.2 Secondary prevention

In the context of MetS, secondary prevention involves early detection/diagnosis of the syndrome, followed by implementation of interventions to address the syndrome as one entity. Interventions usually incorporate strategies to address diet and physical activity in combination, in addition to weight control/maintenance. The following section provides an overview of MetS detection/diagnosis, followed by a summary of the effectiveness of diet and physical activity interventions and their impact on health outcomes for individuals with MetS.

Early detection/diagnosis

MetS is useful for identifying high risk individuals who would have otherwise not been identified using more traditional models of assessing chronic disease risk (Blaha et al., 2008). MetS diagnosis indicates the need for aggressive CVD risk reduction (Zimmet et al., 2005); however, early identification and intervention is often missed by physicians, resulting in underdiagnoses and missed opportunities to address key chronic disease risk factors (Blaha et al., 2008). Obese individuals who are metabolically healthy may not benefit from lifestyle interventions designed for T2DM and CVD (Bays et al., 2013). This highlights the importance of methods that measure abdominal obesity in addition to other CVD risk factors. The IDF criteria is considered most suitable for clinical practice to prevent and manage obesity-related health issues (Kassi et al., 2011). Previous reviews of MetS trials highlight the need for studies to utilise the current evidence and provide up-to-date guidance on the use of IDF to define and screen for MetS (Dunkley et al., 2012; C. Lin et al., 2014).

Metabolic syndrome interventions

Once MetS is diagnosed, interventions should be implemented to prevent the progression to chronic disease. In addition to targeting individual risk factors for CVD and T2DM, prevention research should evaluate interventions that address MetS as one entity (Gami et al., 2007). A systematic review and meta-analysis of RCTs that examined lifestyle interventions for MetS summarised four studies that included both diet and physical activity components (Yamaoka & Tango, 2012). Two of these studies targeted middle-aged adults (55+ years), with sample sizes ranging from 335-502. Both

studies conducted follow-up analysis of one year post-intervention, revealing that the number of individuals with resolved MetS was approximately double that of the control groups which received conventional education (Yamaoka & Tango, 2012). A limitation of this study is the variation in intervention components across the studies, which made it difficult to determine which components were the most effective.

Motivation to change, rather than the prescription of diet and physical activity, is key to resolving MetS as suggested by a review of 28 RCTs of lifestyle interventions (Bassi et al., 2014). Interventions should not only focus on diet and physical activity regimens; they should incorporate strategies to motivate the individual such as personalised feedback and goal setting (Bassi et al., 2014). Further to this, a systematic review of diet and physical activity interventions found a causal link between effectiveness and interventions that incorporated both diet and physical activity strategies in combination with social support and other behaviour change techniques (Greaves et al., 2011). Effectiveness was also associated with the inclusion of goal setting and review, self-monitoring, and feedback. The authors made a number of recommendations for practice, that included promoting changes to both diet and physical activity using well-established behaviour change techniques; delivering in a wide range of settings such as workplaces, community and homes; and a strong focus on maintenance via feedback and motivational techniques (Greaves et al., 2011).

2.5.3 Behaviour change interventions

A prerequisite for primary and secondary prevention is understanding which components of an intervention lead to successful outcomes (Michie, 2008). It is well established that diet and physical activity modifications work to address health outcomes associated with MetS and related chronic diseases; understanding how these interventions work via assessment of behaviour change components is imperative. The following section provides a summary of dietary and physical activity behaviour change interventions as key targets for addressing MetS, at both primary and secondary prevention levels.

According to the National Institute for Health and Care Excellence Guidelines (2014), behaviour change interventions should be designed to include techniques that have demonstrated effectiveness in changing health outcomes. A behaviour change technique is “an observable and replicable component designed to change behaviour” that can be

self-administered or delivered by someone else (Michie et al., 2015). Effective behaviour change techniques include goal setting and planning, feedback and monitoring, shaping knowledge (instruction on how to perform the behaviour), social support, and self-efficacy. Delivery modes can be face-to-face (individual or group), or by distance (population e.g. mass media; individually tailored e.g. telephone, online) (Michie et al., 2015).

A statement from the American Heart Association (2010) provides a comprehensive overview of lifestyle intervention components for promotion of dietary and physical activity behaviour change in adults at risk of CVD. The statement supports the findings of Michie et al. (2015) and provides a description of each behaviour change technique suggested to be effective (Artinian et al., 2010). Goal setting should focus on behaviour rather than a physiological target, and should be realistic and not too difficult to achieve. Self-monitoring allows individuals to recognise their progress towards specific goals and assists with overcoming barriers. Ongoing contact and scheduled follow-up sessions are usually more effective than interventions with one session only, and can be delivered via different modes (face-to-face, email, online). Feedback regarding behaviour performance can enhance motivation and keep the individual on track with specific goals. Self-efficacy enhancement ensures individuals believe in their ability to perform certain behaviours, and problem solving can assist with overcoming barriers to behaviour change. Motivational interviewing is a counselling style that can enhance adherence to behaviour change interventions, and often incorporates the other behaviour change techniques (Artinian et al., 2010).

The statement from the American Heart Association (2010) also provides recommendations for diet and physical activity interventions targeting adults at risk of CVD, suggesting interventions should incorporate the following: goal setting, feedback on goals, self-monitoring, frequent and scheduled contacts, motivational counselling, and problem solving strategies. Additionally, Internet and computer-based programs are appropriate for certain populations (Artinian et al., 2010). These recommendations are supported by the findings of a systematic review of 101 dietary and physical activity behaviour change interventions (Michie, Abraham, Whittington, McAteer, & Gupta, 2009). Interventions varied in duration (one session to 2.5 years), delivery mode (individual or group-based face-to-face), setting (community, workplace, or primary care), location (Australia, Canada, UK, USA, Europe, or Japan), and target group

(disadvantaged, sedentary, obese, at risk of chronic disease, or female). The most effective behaviour change techniques across the studies were self-monitoring in combination with at least one of the following: intention formation, specific goal setting, feedback on performance, and review of behavioural goals (Michie et al., 2009). Based on this information, it is worthwhile investigating different delivery modes for supporting and reaching individuals (face-to-face versus distance).

Multicomponent behavioural weight management and weight loss interventions were evaluated by systematic review to determine the effectiveness of behaviour change techniques applied (Hartmann-Boyce, Johns, Jebb, Aveyard, & Behavioural Weight Management Review, 2014). Studies were included if the participants were 18 years of age and older with a BMI ≥ 25, yielding 37 studies representing 16,000 participants. Most interventions included goal setting, action planning, overcoming barriers, self-monitoring, feedback on performance, instructions on how to perform behaviours, and social support. There was no evidence to suggest one delivery mode was more effective than the other across the studies (face-to-face versus remote) (Hartmann-Boyce et al., 2014). It is worthwhile considering whether there is a difference in effectiveness of different delivery modes for interventions targeting adults with MetS.

A systematic review of RCTs examining the impact of lifestyle modification programs on metabolic risks for adults with MetS was conducted using the Cochrane Collaboration Criteria (Higgins & Green, 2011; C. Lin et al., 2014). Interventions of interest were published between 1985 and 2014, incorporated self-management of diet and physical activity using counselling (including motivational interviewing and empowerment). The review found that lifestyle modification programs can improve health outcomes (systolic blood pressure, triglyceride concentration, and waist circumference), suggesting that diet and physical activity interventions incorporating behavioural modification components address metabolic risks effectively. However, the exact mechanisms of interventions is unknown, suggesting that further research is required to determine the most effective intervention components and delivery modes to achieve these outcomes.

Face-to-face interventions

Face-to-face interventions include individual and group-based programs. The Good Ageing in Lahti Region (GOAL) Lifestyle Implementation Trial (Absetz et al., 2007) was adapted from the Finnish Diabetes Prevention Study (Tuomilehto et al., 2001) for a

primary health care setting. The GOAL intervention incorporated the five key lifestyle changes used by the Diabetes Prevention Study, adopting a group-based counselling model to promote self-monitoring of behaviours, goal setting, planning, and social support. Patients aged 50 to 65 years who had one or more diabetes risk factors (obesity, hypertension, hyperglycaemia, or dyslipidaemia) were referred to a nurse who administered a T2DM risk assessment tool. Those with a score of 12 or more were eligible for inclusion in the study, with a total of 352 assigned to 36 groups. After six group sessions (two hours duration) across a 12 month period, several clinical risk factors improved (diastolic blood pressure, weight, BMI, and waist circumference) despite just 20% of the sample demonstrating attainment of the required lifestyle change objectives. Having these specific lifestyle objectives is helpful for counselling goals and proposed targets; however, understanding which behaviour change techniques are the most and least effective for physical activity and dietary changes needs further exploration.

A systematic review of 74 RCTs found that diet and physical activity behaviour counselling for adults with CVD risk factors (including presence of MetS) supported a reduction in cholesterol concentration, blood pressure, fasting glucose concentration, and diabetes incidence at 12 to 24 months (J. Lin et al., 2014). A number of interventions were intensive and involved many contact hours (median 13 hours) and several months of counselling (median 12 months), and the authors suggested that adherence to the lifestyle components may be greater than in a real world setting, making generalisability difficult. Such interventions place a heavy burden on resources, making them impractical in various settings. The authors suggested that different methods requiring less healthcare resources should be investigated (J. Lin et al., 2014).

Bredhal, Singhammer and Roessler (2011) investigated the change in physical activity and self-efficacy for middle-aged adults allocated to one of two forms of physical activity. Participants were predominantly female (69%) with a mean age of 54.5 (SD 12.9). “Treatment Group” participants had a diagnosed lifestyle disease (MetS, T2DM or CVD) and received motivational counselling plus supervised training. “Preventive Group” participants were at risk of developing the aforementioned lifestyle diseases and received motivational counselling and participated in unassisted training. Measurements were taken at four, 10 and 16 months, and results highlight that physical activity levels can be increased with suggested activities, regardless of intervention intensity

(supervised versus unassisted), provided motivational counselling is incorporated (Bredahl et al., 2011). This suggests that the face-to-face component may not be essential for changing physical activity behaviour; however, lack of randomisation is a limitation of the study.

A study was conducted for adults aged 50 to 75 years with either T2DM or MetS, which consisted of a brief physical activity intervention focusing on self-efficacy and self-regulation (Olson & McAuley, 2015). Participants were recruited via advertisements posted in diabetes clinics and medical centres, and randomised to the eight week exercise intervention group (n=58) or online education group (n=58). Short-term (eight week) physical activity, self-efficacy and self-regulation outcomes improved, but these findings were not sustained at six month follow-up. The authors concluded that interventions lacking long-term efficacy will not be beneficial to overall health outcomes, and suggested longer interventions with strategies to promote behaviour maintenance such as e-health and follow-up communications (Olson & McAuley, 2015).

Distance interventions

Health promotion has been adopting new modes of delivery in an attempt to reach larger numbers of people with lifestyle interventions (Kohl, Crutzen, & de Vries, 2013). These include distance interventions such as population-based or individually-tailored telephone or online programs. A systematic review of online lifestyle interventions found that several behaviour change techniques are effective for improving dietary and physical activity behaviours when incorporated into online programs (Kohl et al., 2013). These include tailored feedback, interactivity, goal setting, and personal contact. However, it is not known which of the intervention components are the most effective under different conditions. The authors suggest testing such components among different population groups such as high risk groups, including adults with MetS.

A number of studies evaluate the effectiveness of online intervention programs to improve diet and physical activity for a range of adult target groups. A systematic review of computer-tailored physical activity and dietary behaviour programs revealed their effectiveness for improving both physical activity and dietary behaviour in healthy adults (Broekhuizen, Kroeze, van Poppel, Oenema, & Brug, 2012). Dynamic tailoring and feedback via tools that promote self-regulation, such as goal setting, email reminders, and self-monitoring tools can improve program effectiveness. In addition, it

is suggested that interactive components to enhance retention, as well as the use of additional media (such as printed material) should also be considered to prompt participants (Neville, O'Hara, & Milat, 2009). A systematic review of studies evaluating the effectiveness of physical activity programs highlighted numerous effective methods for engaging men (Bottorff, Seaton, Johnson, Caperchione, & John, 2015). Tailored, flexible programs with supporting resources (for example printed materials, tracking tools, email and motivational messages) and personal contact were most successful in increasing physical activity levels of male participants. A limitation of this study is that the findings cannot be generalised to women or adults with MetS. This should be investigated further.

Other delivery modes to address diet and physical activity behaviours have been evaluated across a number of studies with a range of target groups, including telephone and social media interventions. A systematic review of physical activity and dietary behaviour change interventions evaluated the effectiveness for initiating and maintaining behaviour change (Goode, Reeves, & Eakin, 2012). Of the 25 included RCTs, 20 reported successful initiation of behaviour outcomes (diet or physical activity), demonstrated by improvements at post-test. Findings suggest that longer-duration interventions are more effective for behaviour change. Some studies compared different delivery modes, and all found that the effectiveness of telephone interventions to be similar to face-to-face delivery modes, particularly when combined with additional modalities such as printed materials (Goode et al., 2012), which has implications for implementing strategies in different settings. A systematic review and meta-analysis of social media interventions for diet and physical activity behaviours found limited effectiveness for improving key outcomes (G. Williams, Hamm, Shulhan, Vandermeer, & Hartling, 2014). Most studies exhibited low participation and poor adherence; however, this can be improved when social media is combined with other modalities incorporating personal feedback and social support. Given the potential to reach large numbers and its popularity among various population groups, this should be further examined (G. Williams et al., 2014).

Motivational interviewing and Self-Determination Theory

As suggested by the American Heart Association (2010), behaviour change techniques can be enhanced by motivational interviewing. Motivation to change, rather than the prescription of diet and physical activity, appears to be key to resolving MetS. A

systematic review investigating optimal methods for achieving lifestyle change in adults with MetS found that interventions incorporating motivational interviewing combined with online monitoring and regular feedback are most effective (Bassi et al., 2014). Behaviour change interventions should be based on behavioural theories to explain how certain strategies such as counselling and goal setting can improve behaviour (Courneya, 2010). Interventions should be tailored to suit individual needs, based on assessment of motivation and readiness to change.

There is value in identifying behaviour change theories from sociology and psychology to ensure sustained behaviour change resulting from interventions (Michie, 2008). Self-Determination Theory and motivational interviewing were originally developed by different people and for different purposes; however, there is considerable overlap in the facilitation of behaviour change (Patrick & Williams, 2012). Self-Determination Theory emphasises autonomous motivation for behaviour change in lieu of controlled behaviour change (Patrick & Williams, 2012). The Theory emphasises intrinsic motivation to ensure behaviours are adopted for the sake of the individual rather than for the benefit of someone or something else. Many health behaviours are commonly extrinsic in nature (for example social acceptance and rewards), such as making dietary changes or losing weight. There is evidence that individuals with higher autonomous motivation and self-efficacy tend to engage in consistent health-promoting behaviours in the long-term, independent of age, race and income level (Janssen, Dugan, Karavalos, Lynch, & Powell, 2014). Considering this, intervention design should be based upon theories that aim to motivate autonomously. Evidence suggests that Self-Determination Theory provides the basis for autonomous motivation to promote sustained behaviour change in high risk adults (Janssen et al., 2014).

2.6 Rural and remote interventions

A small number of studies have been conducted in rural or remote areas targeting adults who have one of the following conditions which increase the risk of T2DM and CVD: impaired glucose tolerance, central obesity, dyslipidaemia, hypertension, overweight/obesity, or MetS. Studies summarised in this section included a dietary and/or physical activity behaviour change component with one or more of the following behaviour change techniques: goal setting, personal feedback, self-monitoring, or social support. Studies incorporating motivational interviewing, counselling, or Self-Determination Theory have also been summarised. Outcomes reported include

improvements in dietary and/or physical activity behaviour or improvements in health outcomes associated with T2DM and CVD risk.

Rural interventions for adults with metabolic syndrome risk factors (primary prevention)

A number of studies involve participants who do not have a MetS diagnosis, but have one or more risk factors for T2DM or CVD. The GOAL intervention (Absetz et al., 2007) was modified for a rural Australian context to evaluate feasibility and effectiveness in primary care. The Greater Green Triangle Diabetes Prevention Project (Kilkkinen et al., 2007) recruited 311 rural participants aged 40 to 75 years who were considered to be at moderate risk of T2DM (score ≥12) according to the Diabetes Risk Score Tool (Jaana. Lindström & Tuomilehto, 2003). The intervention component was similar to the GOAL intervention, with six group sessions administered over a 12 month period, based on the Australian Dietary Guidelines and Physical Activity Guidelines. Goal setting, self-regulation, self-monitoring, and social support were the main behaviour change techniques employed. After three months, significant improvements in total cholesterol concentration (-3.49%), LDL cholesterol concentration (-4.75%), BMI (-2.51%), weight (-2.46%), waist circumference (-1.55%), and hip circumference (-2.73%) were observed, and maintained over 12 months (Laatikainen et al., 2007). These findings suggest that this type of intervention is feasible in a primary care setting; however, the intensive delivery mode may not be suitable for some rural settings with limited resources and an inability to conduct group programs. Other delivery modes should also be investigated.

The Diabetes Prevention Program (Diabetes Prevention Program Research Group, 2002) was adapted for a rural context and implemented in Montana, USA (Vadheim et al., 2010). Participants (n=84) were ≥ 18 years of age, overweight or obese (BMI ≥ 25 kg/m^2), and had one of the following T2DM or CVD risk factors: prediabetes, impaired glucose tolerance, impaired fasting glucose, hypertension, dyslipidaemia, or a history of gestational diabetes. The adapted intervention was delivered by trained lifestyle coaches and consisted of 16 weekly group sessions for behavioural self-management strategies for weight loss, which covered diet education to reduce fat intake, and physical activity information, followed by supervised sessions. At the end of the 16 week program, 52% of participants reduced their body weight by the desired 7% which is comparable to the original study. A limitation of this study is the lack of control group and objective

measures. Although the original study demonstrated a reduction in diabetes incidence by 58% for the intervention group (Diabetes Prevention Program Research Group, 2002), caution should be exercised when extrapolating these results to a rural sample. Further to this, the rural study failed to report on the intervention components which may have been responsible for the improved health outcomes. Further examination of such behaviour change techniques for rural populations is warranted.

A similar adaptation was made from the Diabetes Prevention Program to address obesity in women aged 50 to 75 years, residing in rural counties across Florida (Perri et al., 2008). Participants (n=234) were required to have a BMI $\geq$ 30 kg/m^2, without a diabetes or CVD diagnosis. Modifications of the Diabetes Prevention Program included the introduction of home-based physical activity sessions and group sessions instead of individual counselling. Three arms were included in the trial: telephone counselling (n=72); face-to-face counselling (n=83); and education control (n=79). Sessions in the two intervention arms were group-based and delivered by trained health professionals (such as dietitians and nutritionists), and consisted of diet and physical activity modifications supported by behaviour change techniques such as goal setting and self-monitoring. Both intervention arms demonstrated significant improvement in weight (-10.0 kg, SD 0.4) with no differences observed between the two groups. There was also a higher level of adherence to these two interventions than the education control, suggesting that the use of behaviour change techniques can improve adherence. The findings also suggest that telephone counselling is a cost-effective strategy for weight maintenance in underserved rural areas compared to other delivery modes, although the results cannot be extrapolated to men. The effect on diet and physical activity behaviour is also unknown. Considering these limitations, the effectiveness of similar intervention strategies for behavioural outcomes in rural men and women should be investigated.

The Diabetes and Technology for Increased Activity study evaluated the effectiveness of a lifestyle intervention which consisted of self-monitoring of specific health outcomes (blood pressure and fasting blood glucose) and physical activity behaviour (Stuckey et al., 2011). The study was conducted in a rural population in Canada, and participants (n=24) were required to have at least two MetS risk factors (high waist circumference or obesity, hypertension, impaired glucose tolerance, or dyslipidaemia). Over the eight week program, participants attended education and training sessions three times per week, and transmitted their self-monitored health and behaviour

outcomes via wireless platforms. Significant improvements in physical activity levels, waist circumference (-3.86 cm) diastolic blood pressure (-5 mmHg), BMI (-0.4kg/m^2) total cholesterol concentration (-0.29 mM), and steps per day (+1086 steps/day) were observed. Because this was conducted as a feasibility study, a control group was not included (Stuckey et al., 2011). It is worth investigating a similar strategy in a rural setting via a RCT to determine whether the intervention components such as self-monitoring can be responsible for improved MetS risk factors.

The feasibility of an online weight loss intervention for obese adults was assessed by a pilot study conducted in a Midwestern state of the USA (Pullen et al., 2008). Participants (n=21) were required to be female, aged 50 to 69 years, and overweight or obese (BMI $\geq$ 25 kg/m^2), residing in a rural area, with internet and computer access. Randomisation into website only or website plus support group occurred after baseline assessment. The website consisted of diet and physical activity recommendations, based on the following behaviour change techniques: self-efficacy, social support, perceived benefits, goal setting, self-monitoring, and overcoming barriers. The support group received access to the website plus a peer-led support group that encouraged group discussion and supported the participants in their behaviour change attempts. The group receiving the peer-led support demonstrated greater improvement in weight, waist circumference, blood pressure, fruit and vegetable serves, and wholegrain serves compared to the website only group, suggesting that social support is an important inclusion in such behaviour change interventions. Limitations of this study were the small sample size and lack of male participants, making generalisability to other rural areas difficult. However, the preliminary findings are encouraging given the potential to implement similar interventions in underserved rural areas remotely at low cost.

Rural interventions for adults with metabolic syndrome (secondary prevention)

A small number of behaviour change interventions have been implemented in rural areas targeting adults with diagnosed MetS. One such study was a four week lifestyle modification pilot RCT targeting women with MetS in rural Korea (Oh et al., 2008). MetS was diagnosed using the ATPIII criteria and 32 women were randomised to an intervention (n=16) or a control (n=16) group. The intervention was delivered over 12 sessions via an information booklet and consisted of education, supervised physical activity, diet modifications, and counselling delivered by a nurse researcher.

Improvements were observed for health behaviours, body weight (-4.6 kg), waist circumference (-6.2 cm), and triglyceride concentration (-52.2 mg/dL); however, there were no intervention effects for psychosocial outcomes such as self-efficacy and quality of life (Oh et al., 2008). Based on this pilot study, a six month intervention was implemented with a larger sample (n=52) of a similar target group (n=31 intervention; n=21 control) (Oh et al., 2010). The intervention consisted of similar components to the pilot, except 60 sessions were delivered over a 6 month period. Reduced prevalence of MetS was observed for the intervention group (67% resolved cases compared to 30% in the control group). The exclusion of effective behaviour change techniques in the intervention may explain the lack of improvement in self-efficacy; however, the counselling component was not well described by the authors, making it difficult to confirm this hypothesis. The sample size, location, and lack of male participants are also limitations of the study, making these results difficult to extrapolate.

The Support, Health Information, Nutrition and Exercise program (Weinstock et al., 2013) was another adaptation of the Diabetes Prevention Program (Diabetes Prevention Program Research Group, 2002), which aimed to evaluate the effectiveness of a telephone-delivered translation intervention. Participants (n=257) were recruited from five primary care provider sites in upstate New York (one site from a rural area) and randomised to a conference call (n=128) or individual call (n=129) intervention. Inclusion criteria were ≥ 18 years of age and presence of MetS using the IDF definition. Both interventions consisted of the Diabetes Prevention Program curriculum which included goal setting, self-monitoring, problem solving, and diet and physical activity modifications, with sessions delivered across 12 months. Results demonstrated that both intervention delivery modes were effective for weight loss (-5.6% body weight for the conference call group versus -1.8% for the individual call group), suggesting that telephone interventions can be implemented remotely with minimal physician involvement. A limitation of this study was that diet and physical activity behaviours were not reported, nor were other health outcomes (MetS status and individual parameters). It is also unknown which behaviour change techniques were the most effective, and whether the effects were similar in the rural site compared to the other sites.

In summary, there is a paucity of behaviour change interventions targeting rural adults *with*, or *at risk* of MetS, particularly in an Australian context. Rural areas of Australia

are unique in their chronic disease risk factors and determinants, particularly due to isolation and lack of access to services, which is supported by the highlighted differences in morbidity and mortality between rural and other areas. It is therefore important that behaviour change interventions are implemented and evaluated in the Australian context. Based on the best available evidence, rural interventions should incorporate both diet and physical activity modifications supported by a combination of behaviour change techniques, particularly goal setting and self-monitoring. Telephone and online delivery modes seem to have similar effectiveness as face-to-face delivery modes for rural populations, provided behaviour change techniques are adequately incorporated into interventions. Lack of access to health services in rural and remote areas may be overcome by offering home-based lifestyle interventions (M. Moore, Warburton, O'Halloran, Shields, & Kingsley, 2016) delivered via telephone and internet. Additionally, recruiting rural adults who are *at risk* of MetS (at least two risk factors) as well as rural adults diagnosed *with* MetS for behaviour change interventions will have a positive impact on a number of health outcomes associated with T2DM and CVD. These findings are based on studies with a number of limitations and as such, future rural interventions should engage larger sample sizes, incorporate well-defined behaviour change techniques, and evaluation of behavioural outcomes, health outcomes, and processes that are adequate to determine effectiveness.

2.7 Process evaluation

Recording indicators of external validity via process evaluation is essential to understanding the extent to which interventions can be effective in “real-world” settings (Goode et al., 2012). Behaviour change intervention trials should report fidelity and adherence to intervention components to support an understanding of their applicability and effectiveness in different settings (J. Lin et al., 2014). For example, most behavioural weight management interventions incorporate a combination of diet and physical activity components; however the type, number, and duration of sessions and behaviour change techniques differ greatly (Hartmann-Boyce et al., 2014). Determining the most effective components is vital to ensuring future interventions achieve their desired outcomes. To enable more rigorous control of potential confounders, researchers should clearly report the characteristics of interventions, particularly dietary and physical activity behaviour change techniques and components (Hartmann-Boyce et al., 2014). This will assist with translating research findings into practice, by reporting on elements of the intervention such as delivery, participant reach, and fidelity.

2.8 Conclusions

MetS increases the risk of T2DM and CVD, and its components are strongly associated with overweight/obesity and age. Older adults in rural and disadvantaged areas are considered to be at an increased risk of MetS and associated chronic disease due to the higher prevalence of risk behaviours, poorer health outcomes and less health services; yet interventions targeting these groups are lacking. There is a plethora of evidence to suggest that combined diet and physical activity interventions are the most effective for reversing MetS, individual parameters, and related chronic diseases. Both primary and secondary prevention strategies appear effective, particularly secondary prevention due to the opportunity to identify and target high risk individuals. Some studies highlight difficulty of maintaining health outcomes in the longer term. The key is how to support and maintain diet and physical activity behaviour change via various behaviour change techniques in high risk adults, to ensure improved health outcomes.

More research into the most effective behaviour change techniques and delivery modes for rural Australian adults *with* or *at risk* of MetS is required. By identifying individuals *at ris*k of MetS as well as those *with* MetS, a greater number of high risk individuals can be targeted. The link between poor diet, physical inactivity, central obesity, and MetS is well-established; therefore the use of the IDF definition for identifying adults at increased risk of developing T2DM and CVD should be further explored, due to the inclusion of central obesity in the diagnostic criteria. Primary outcomes should measure changes in dietary and physical activity behaviour, and secondary outcomes should assess changes to health outcomes. Process evaluation should also be conducted to report on components of the intervention that were most effective, and to ensure the program was implemented as intended. This is typically underreported in RCTs, and is particularly important in behaviour change interventions. Combining these outcome and process measures will enable determination of the most effective mechanisms for behaviour change and their subsequent impact on health outcomes.

3.0 Research methods

This section expands on the protocol paper (**Publication 1**, Appendix A) which is written in future tense. It describes the study design, town selection, participant selection, study procedure, screening, outcome and exposure variables, sample size and power calculations, data analysis, ethics, intervention, and process evaluation as they were carried out. This section addresses Objective 1:

1. Design and implement a RCT of a home-based intervention to improve the physical activity and dietary behaviours of adults aged 50-69 years *with* or *at risk* of MetS, residing in a rural community.

Related publication:

1. **Blackford, K.**, Jancey, J., Lee, A. H., James, A., Howat, P., Hills, A. P., & Anderson, A. S. (2014). A randomised controlled trial of a physical activity and nutrition program targeting middle-aged adults at risk of metabolic syndrome in a disadvantaged rural community. *BMC Public Health*, *15*, 284. http://dx.doi.org/10.1186/s12889-015-1613-9. [Impact Factor 2.26]

3.1 Study design

This study was a 6-month RCT of a home-based physical activity and dietary behaviour change intervention for adults aged 50 to 69 years *with* or *at risk* of MetS, residing in rural WA (Albany and environs). The trial was registered with the Australian and New Zealand Clinical Trials Registry [ACTRN12614000512628, registration date 14th May 2014]. Table 3.1 outlines the study design and intervention process.

Table 3.1. Intervention process

Study group			
	0 months (baseline)	Intervention	6 months (Post-test)
Intervention (n=201)	O1	X	O2
Control (n=200)	O1		O2

O = observation; X = intervention

3.2 Ethics

Ethical approval of the study was obtained from the Human Research Ethics Committee of Curtin University, ethics approval number HR149_2013 (Appendix F, Ethics Approval). All participants were informed of the research aims and objectives, the nature of their involvement, who was conducting the research, and that confidentiality would be maintained throughout the study. An information sheet and consent form (Appendix F, Consent Form) was provided prior to entry into the study and participants were free to withdraw from the program at any time. Participants were given an opportunity to contact the research team to ask questions prior to signing the consent form. An opportunity was also provided at the clinic visit. Hard copies of the questionnaires were collected and stored at Curtin University in a locked filing cabinet. Only the research team had access to the questionnaires. Data were also stored electronically on the Curtin server which was password protected and only accessible to the research team. All original data will be retained for five years post publication date, following ethical guidelines.

3.3 Study location selection

The City of Albany and environs (50 km radius approximately) in the Great Southern region of WA was selected as the study location for this research. The combined residential population of the Local Government Area of Albany and environs (41,605 residents) (Australian Bureau of Statistics, 2013d) is classified as a rural area according to population size (<99,999) (Australian Institute of Health and Welfare, 2004), and was sufficient to implement and evaluate the program. There were sufficient adults in the target age group of 50-69 years (10,870) (Australian Bureau of Statistics, 2013d) which is a similar demographic profile to other rural areas in Australia. In addition, the SEIFA score for Albany (987.4) indicates relative disadvantage (<1000) (Australian Bureau of Statistics, 2013c). Socio-economic disadvantage is associated with higher prevalence of risk factors for chronic disease compared with less disadvantaged areas (Australian Bureau of Statistics, 2013c). Figure 3.1 outlines the study location.

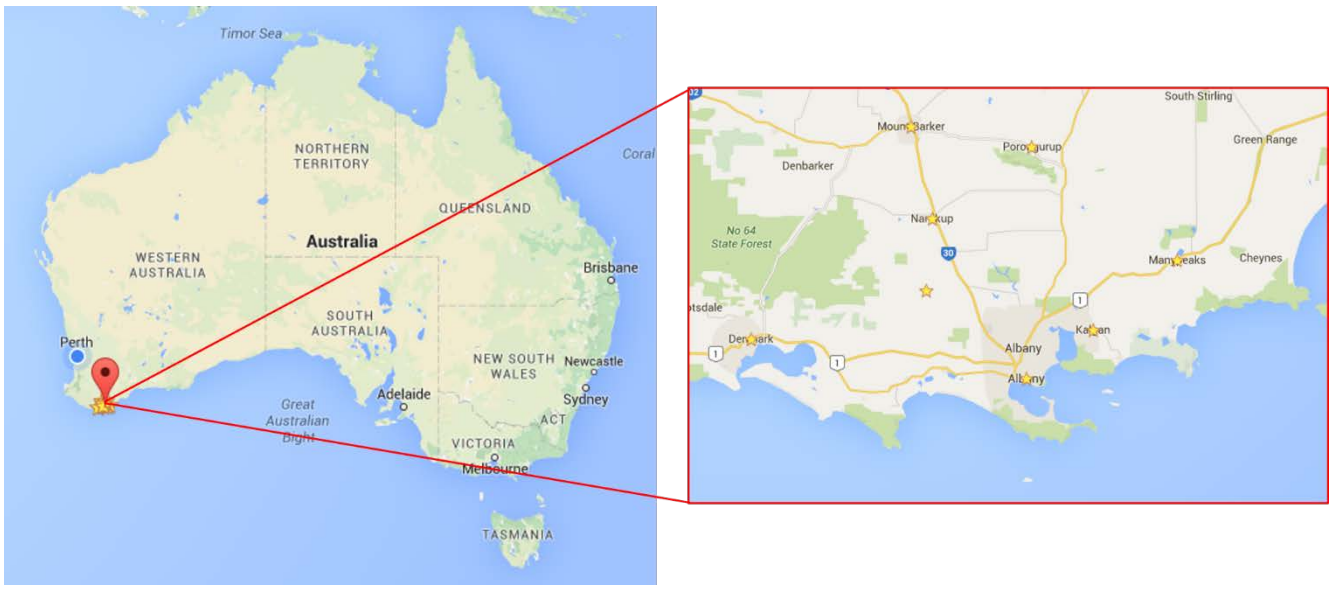

Figure 3.1. Study location
Retrieved from www.google.com.au/maps

3.4 Participant selection

Prospective participants were required to be aged 50 to 69 years and satisfy the IDF MetS criteria (Han & Lean, 2006): central obesity (waist circumference ≥94 cm men or ≥80 cm women [Europids, Sub-Saharan Africans, Eastern Mediterranean, Middle East]; ≥90cm men or ≥80cm women [South Asians, Chinese, Japanese]); plus any two of: raised triglyceride concentration (≥1.7 mM, or treatment for this); reduced HDL-cholesterol (<1.03 mM in males and <1.29 mM in females, or treatment for this); raised blood pressure (systolic ≥130 mmHg or diastolic ≥85 mmHg, or treatment of previously diagnosed hypertension); raised fasting plasma glucose (≥5.6 mM) (Kaur, 2014). However, if individuals met the above requirement for central obesity and satisfied one (instead of two) of the latter four conditions as specified by IDF, they were classified as being *at risk* of developing MetS and were included in the present study with the aim of preventing the onset of MetS and associated chronic diseases (Hsiung, Liu, Cheng, & Ma, 2014).

The following exclusion criteria were applied: previous diagnosis of diabetes mellitus (other than gestational diabetes); receiving specific treatment to lower blood glucose; on a weight loss diet or having weight fluctuations of >5% within the previous 6 months; of Aboriginal or Torres Strait Islander decent; or involvement in another physical activity study or program.

3.5 Sample size and power calculations

The power calculations were based on a logistic mixed regression model with the outcome variable being the prevalence of physical activity participation. In the power analyses, effect sizes of interest are associated with the time (pre-post) and intervention group parameters. For the mixed regression analysis, a final sample size of n=400 [100 per gender by intervention condition] provided sufficient power (80%) to detect a medium effect size for physical activity behaviour as a primary outcome at 5% significance level for the group by time interaction term accounting for gender but without other covariate adjustment.

3.6 Procedure

Recruitment occurred in three stages and the procedure was staggered over a 14-month period from October 2013 to December 2014. Figure 3.2 outlines the study procedure.

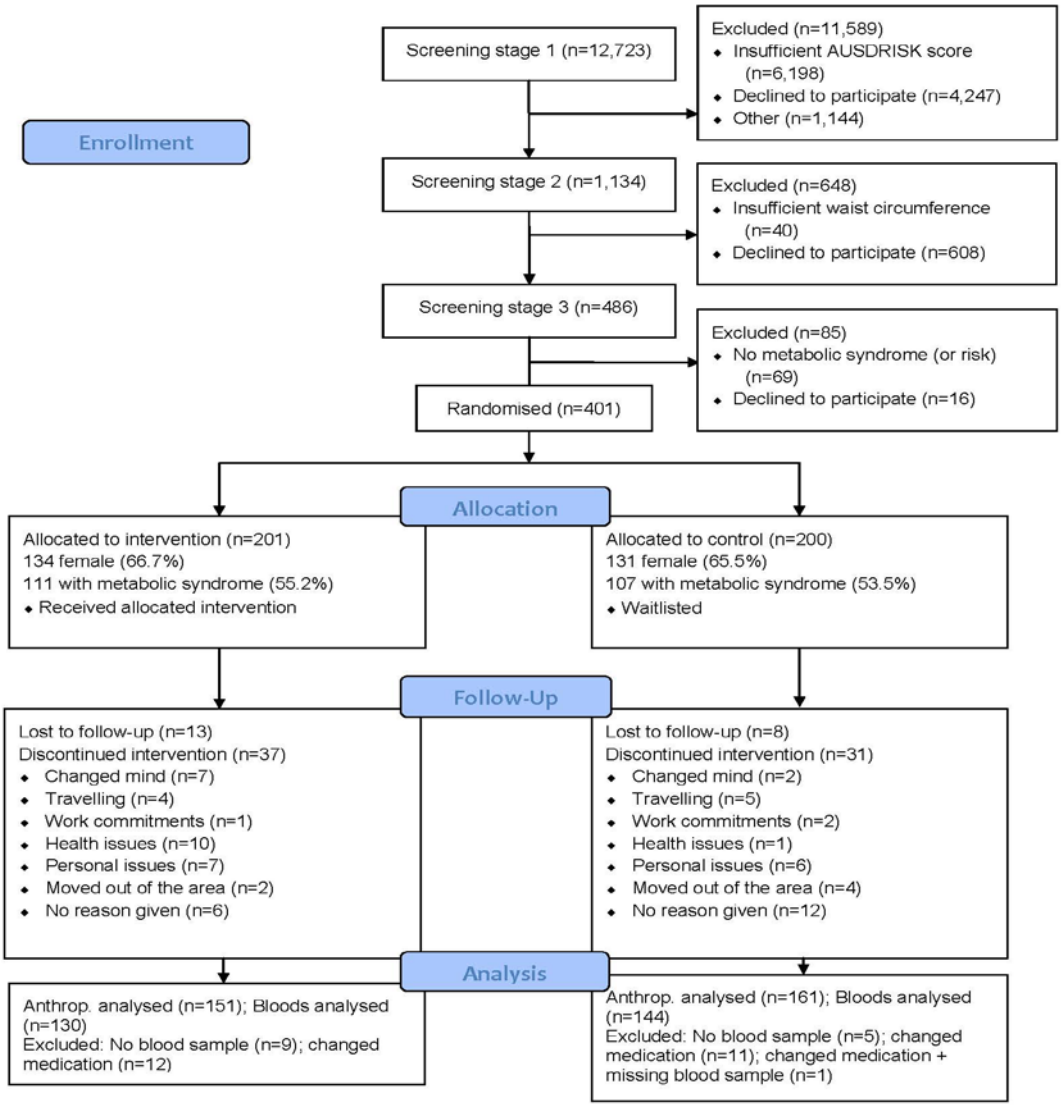

Figure 3.2. Study procedure

3.6.1 Screening stage one

Based on a previously successful recruitment strategy (Burke et al., 2010), residents from the selected towns were contacted via a Computer Assisted Telephone Interview (CATI) system. Telephone numbers were extracted from the White Pages based on postcodes, and a total of 12,723 numbers were contacted. A postcard was also sent to residents of the towns to provide information on the study and to inform them that someone may contact them in the coming weeks (Iredell, Shaw, Howat, James, & Granich, 2004). During the initial telephone contact, the purpose of the study was explained and the caller determined whether the individual met the initial criteria (Appendix A, Initial Screening Questionnaire): aged between 50 to 69; no previous diagnosis of diabetes mellitus (other than gestational diabetes); not receiving specific treatment to lower blood glucose; not on a weight loss diet or having weight fluctuations of >5% within the previous 6 months; not of Aboriginal or Torres Strait Islander decent; and no involvement in another physical activity program.

Individuals were then screened for diabetes risk factors based on the AUSDRISK, the Australian T2DM risk assessment tool (Chen et al., 2010) (Appendix D, AUSDRISK). This simple and reliable questionnaire identifies individuals at risk of developing T2DM based on demographics, health behaviours, and anthropometry (Chen et al., 2010): age, sex, ethnicity, family history of diabetes, previous blood glucose concentration, use of blood pressure medications, smoking status, physical activity level, and waist circumference. Of the 12,723 telephone contacts, 7,332 agreed to undertake the screening stage one. Table 3.2 provides a summary of reasons 5,391 contacts did not progress to the initial screening questions.

Table 3.2. Recruitment call statistics

	n
Yes	7332
Not willing to participate	4247
Language barrier	45
Business	589
Fax	363
Non-resident of WA	6
Hearing impaired	37
Other reasons	104
Total	12723

Of the 7332 who agreed to undertake screening stage one, 1,134 met the selection criteria and achieved the required AUSDRISK score (≥ 9 female or ≥ 12 male) to be eligible for screening stage two. These 1,134 potential participants were informed of the study aims and requirements, and were invited to participate. Callers recorded contact details of those indicating an interest. Table 3.3 provides a summary of the reasons for exclusion prior to screening stage two.

Table 3.3. Reasons for exclusion prior to screening stage two (n=6,198)

Reason	n	%
Outside age group (50-59 years)	3586	57.9
Not in area	824	13.3
Aboriginal or Torres Strait Islander descent	43	0.7
Involved in another research program	31	0.5
Weight fluctuations ± 5% body weight	215	3.5
Diabetic	157	2.5
Gastric banding	15	0.2
Physically active	536	8.6
Insufficient AUSDRISK score	791	12.8

3.6.2 Screening stage two

The 1,134 potential participants were sent an information sheet (Appendix E, Information Sheet) with a covering letter (Appendix E, Cover Letter), inviting them to attend a clinic in a central location in Albany. The information sheet explained the home-based intervention, their rights, and confidentiality details. Participants were provided with the clinic contact details and an appointment was made to attend the clinic for anthropometric measurements and blood pressure readings to be taken, and the completion of a questionnaire (Appendix E, Questionnaire). Participants signed a consent form at the clinic in the presence of the Researcher prior to measurements being taken. A total of 526 participants attended the clinic for screening stage two.

Waist circumference was included in screening stage two due to central obesity being an essential component of the IDF MetS criteria and ease of measurement (Zimmet et al., 2005). Participants who did not meet the central obesity criteria (waist circumference >94cm men or >80cm women) were excluded (n=40). An additional 16 participants withdrew prior to their fasting blood sample, leaving a total of 470 eligible for screening stage three.

3.6.3 Screening stage three

Individuals with confirmed central obesity were provided with a pathology form for the collection of a fasting blood sample (for measurement of triglyceride, glucose, and cholesterol concentrations) to determine their MetS status. Participants were eligible if they were classified as either *with* MetS or *at risk* of MetS, based on the criteria listed in section *3.4 Participant selection*. Sixty nine participants did not meet the eligibility criteria based on their fasting blood samples and were therefore excluded.

A total of 401 participants were eligible for the study and randomised to either the intervention (n=201) or control (n=200) group, with quota sampling for sex and MetS status. Table 3.4 provides a summary of the participants included in the study. Intervention participants received the intervention materials and the control group was placed on a waitlist to receive the intervention after they completed the post-test data collection. This group was informed of their eligibility for the study after baseline data collection. Previous interventions have successfully adopted this method of wait-listing the control group (Lewis, 2013; Nakade et al., 2012).

Table 3.4. Participants randomised (n=401)

MetS status and sex	Intervention (n=201)	Control (n=200)
With MetS, female	67	63
At risk of MetS, female	67	68
With MetS, male	44	44
At risk of MetS, male	23	25

3.7 Intervention

3.7.1 Program design

The intervention group participants received a package of printed materials designed to educate and motivate nutrition and physical activity improvements and healthy weight management using behaviour change techniques known to be effective for dietary and physical activity behaviour change in adults at risk of CVD (Artinian et al., 2010). The program was adapted from a previous study (Burke et al., 2010) for a rural context, incorporating telephone support rather than face-to-face support, and was based on the principles of Self-Determination Theory and motivational interviewing (Kerr et al., 2012; Patrick & Williams, 2012). The key constructs of Self-Determination Theory include autonomy, competence and relatedness; experiences of dealing with the

environment and the ability to control the course of their lives fosters motivation and engagement, which results in persistent and improved participant behaviours (Kerr et al., 2012; Patrick & Williams, 2012). Goal setting, self-monitoring, feedback and shaping knowledge formed the basis of the home-based program, empowering participants to self-manage their health behaviours within their own environment in an autonomous manner.

The intervention was safe, accessible, and low-cost, commencing at a low level of physical activity. Exercises were based on Australia's Physical Activity and Sedentary Behaviour Guidelines (Department of Health, 2014) and included aerobic, strength, and flexibility components, with tips and instructions for performing the exercises safely. The dietary component was based on the Australian Dietary Guidelines (National Health and Medical Research Council, 2013a), encouraging increased consumption of fruit and vegetables, and limiting consumption of saturated fat, sodium, and added sugar. The intervention also encouraged regular self-monitoring of weight and waist circumference, which is generally associated with greater weight loss (VanWormwer et al., 2009).

3.7.2 Program materials

Booklet

The *Albany Physical Activity & Nutrition (APAN) Eat Healthy, Move More, Sit Less* booklet (Appendix G, APAN Booklet) was developed and comprised five sections. The *Maintaining a Healthy Weight* section included information on overweight and obesity as a risk factor for chronic diseases, causes of weight gain, and how to assess weight status using BMI and waist circumference (National Health and Medical Research Council, 2013b). The *Physical Activity* section included Australia's Physical Activity and Sedentary Behaviour Guidelines (Department of Health, 2014), health benefits of being physically active, examples of activity types (moderate, strength, flexibility, and balancing exercises), goal setting and making a plan, and overcoming barriers. The *Home-based Physical Activity Program* section included instructions and illustrations for performing a range of exercises in the home setting. The *Nutrition* section summarised the Australian Dietary Guidelines (National Health and Medical Research Council, 2013a) and the five food groups, recommended serves for adults, fat types, low glycaemic index foods, alcohol guidelines (National Health and Medical Research Council, 2009), sample daily meal plans, goal setting, healthy shopping tips, and

healthy recipes. The *Health Monthly Activity Planner* section provided participants with 6 months of activity planning and recording for the suggested activities and exercises.

Exercise charts and resistance band

The APAN *Your Exercise Chart* (Appendix G, APAN Exercise Charts) provided participants with a series of photos and written instructions for performing a range of exercises in their home. These included warm up stretches for improving flexibility; strength and balance exercises; exercises to be performed while watching television; and 'kettle exercises' which could be performed while waiting for the kettle to boil.

Nutrition panel wallet card

The APAN nutrition panel wallet cards, *Reading Nutrition Panels* (Appendix G, APAN Nutrition Panel Wallet Cards), were designed to provide assistance to participants when reading nutrition labels at the supermarket. The card included common information found on nutrition panels including total fat, saturated fat, sugar, sodium, fibre, and amounts per 100g considered to be healthy options (National Health and Medical Research Council, 2013c).

Website and progress tracker

The *APAN Website* was developed to provide all program materials in an electronic format. The pages followed the booklet format, and the exercise charts were available as downloadable documents. A blog was developed and monitored regularly to share program updates, news, health information and links, with a section for participants to comment and interact. The website also included a daily progress tracker, allowing participants to log their physical activity, nutrition, and weight management progress (Appendix G, APAN Website Progress Tracker). The website was password protected, allowing access to the intervention group only.

3.7.3 Follow-up and support

The intervention group participants were allocated to one of two research assistants who were trained in motivational interviewing techniques (Resnicow & McMaster, 2012). Telephone contact was made with participants at weeks 1, 3, 6, 12, 18, and 24 of the intervention to ensure effective program delivery and to maintain motivation and participation. The research assistants discussed and monitored goal setting and provided support as needed. Follow-up emails were also sent, and participants were given the option to contact the research assistants as required.

3.7.4 Control group

After baseline data were collected and eligibility was confirmed, participants allocated to the control group were waitlisted and received the program materials (booklet, exercise chart, and resistance band only) after the post-test data was collected. No contact was made with the control group during the intervention other than to confirm eligibility for the program.

3.8 Measures

The following objectives are addressed in this section:

4. Assess at post-test the change in physical activity and dietary behaviours of intervention participants relative to the control group (primary outcomes).
5. Assess at post-test the change in body composition, MetS parameters, and cardiovascular risk factors for the intervention group relative to the control group (secondary outcomes).
6. Assess the change in MetS status and CVD risk scores post-intervention relative to the control group (secondary outcomes).

Table 3.5 summarises measurement of each outcome and exposure variable, measured at baseline and 6-months post-test.

Table 3.5. Outcome variables and measurement instruments

Outcome variable	Measurement instrument
Demographics and lifestyle (Sex, age, education, marital status, diagnosed conditions, medications)	Questionnaire
Primary outcomes	
Sedentary and physical activity behaviours	IPAQ-SF (Burke et al., 2010; Craig et al., 2003)
Dietary behaviours (fat, fibre, fruit, vegetable consumption)	Fat & Fibre Barometer (Wright & Scott, 2000)
Secondary outcomes	
Anthropometric measurements (BMI, waist circumference, waist-to-hip ratio, body fat and muscle percentage)	Bioelectrical impedance analysis, stadiometer, measuring tape (O'Brien, Waeber, Parati, Stassen, & Myer, 2001; Omron Corporation Japan, 2002),
Blood pressure	OMRON automatic BP monitor
Glucose, triglyceride, cholesterol (total, LDL, HDL, non-HDL, remnant chol)	Blood samples (Grundy et al., 2004)
MetS diagnosis/status	IDF criteria (Han & Lean, 2006)

Outcome variable	Measurement instrument
CVD risk	Australian absolute CVD risk calculator (National Vascular Disease Prevention Alliance, 2012)

3.8.1.1 Self-reported physical activity and dietary behaviours

A self-reported questionnaire was completed by all participants at baseline and 6 months and included questions on demographics and lifestyle, the International Physical Activity Questionnaire Short Form (IPAQ-SF) (Craig et al., 2003), and the Fat & Fibre Barometer (Wright & Scott, 2000). Demographic and lifestyle questions included sex, age, education, marital status, smoking status, alcohol consumption, diagnosed health issues, and current medications. *The IPAQ-SF* (Craig et al., 2003) is a self-administered instrument that allows population surveillance of physical activity, inactivity, and sedentary behaviour in adults aged 15 to 69 years. The instrument has undergone validity and reliability testing in 12 countries including Australia, and is recommended for monitoring of physical activity in large studies. The repeatability is acceptable, with 75% of the correlation coefficients above 0.65, and the criterion validity shows fair to moderate agreement with accelerometers (p=0.30).

The Fat & Fibre Barometer (Wright & Scott, 2000) is a brief self-administered dietary behaviour questionnaire which provides useful information on fat and fibre intake behaviours. The instrument is reliable (Cronbach's alpha of 0.86) and demonstrates good test-retest scores (r=0.92). The relative validity when measured against the Food Frequency Questionnaire for total fat, percentage of energy from fat, total fibre, and fibre density is r=-0.60, -0.57, 0.44, and 0.76, respectively. This instrument has been used in recent similar studies targeting middle-to-older age adults (Burke et al., 2010; Holt et al., 2014).

3.8.2 Anthropometric measures

Anthropometric measurements were taken at baseline and at 6-months, following the International Society for the Advancement of Kinanthropometry guidelines (The International Society for the Advancement of Kinanthropometry, 2001). *BMI* was calculated by dividing weight (kg) by height (m) squared. *Height* was measured to the nearest 0.1 cm with a portable stadiometer while the participant was barefoot. *Weight*

was measured to the nearest 0.01 kg using an electronic weight scale while barefoot and wearing lightweight clothing. *Waist* circumference was measured to the nearest 0.5 cm at the level midway between the lowest rib margin and the iliac crest while the participant stood upright. *Hip* circumference was measured to the nearest 0.5 cm at the largest level of the symphysis pubis and gluteus maximus while the participant stood upright. *Waist-to-hip ratio* was calculated by dividing waist circumference (cm) by hip circumference (cm) (Welborn et al., 2003).

3.8.3 Blood pressure

Blood pressure was measured using an Omron M5-1 electronic sphygmomanometer. A mean value was recorded after three consecutive measurements at intervals of one minute (Pickering, Falkner, Jones, & Roccella, 2005). The participant was in a sitting position with legs uncrossed and using a back support. The cuff was placed on the upper arm, with the arm at the level of the right atrium and the stethoscope at the elbow crease over the brachial artery (Pickering et al., 2005).

3.8.4 Fasting blood samples

Fasting blood samples were taken by a phlebotomist at baseline and 6 months. Fasting plasma glucose was determined to assess glycaemic control, which is strongly associated with other MetS parameters and is correlated with CVD risk (Grundy et al., 2004). Fasting lipid concentrations were determined to assess lipid profile and CVD risk. The concentrations of triglyceride and total cholesterol were measured allowing determination of LDL-, HDL-, non-HDL-, and remnant cholesterol concentrations (Nordestgaard & Varbo, 2014). Triglyceride, total cholesterol, HDL cholesterol and glucose were determined using enzyme-based colourimetric reagents (CV < 5%), and LDL cholesterol was estimated using the Friedewald Equation (Fukuyama et al., 2008). All blood tests were performed by Western Diagnostic Pathology using their routine automated procedures using a Siemens Advia 2400 analyser.

3.8.5 Metabolic syndrome status

MetS status was determined using the IDF criteria (Han & Lean, 2006), which accounts for central obesity being common to each of the other MetS parameters (Zimmet et al., 2005). Under this classification, increased waist circumference was a necessary requirement for diagnosing individuals, which served as the initial screening test for MetS (Zimmet et al., 2005). As stated in section *3.6.2 Screening stage two*, only

individuals satisfying the central obesity requirement were eligible for the subsequent screening stage three (fasting blood sample). Participants who satisfied the full criteria (central obesity plus two other parameters as listed below) were classified as *with* MetS; whereas those with central obesity (waist circumference >94 cm men or >80 cm women [Europids, Sub-Saharan Africans, Eastern Mediterranean, Middle East]; >90 cm men or >80 cm women [South Asians, Chinese, Japanese]) plus one of: raised triglyceride concentration (>1.7 mM, or treatment for this); reduced HDL-cholesterol (<1.03 mM in males and <1.29 mM in females, or treatment for this); were classified as being *at risk* of MetS. Post-test reclassification determined changes to MetS status after 6 months.

3.8.6 Cardiovascular disease risk

Absolute CVD risk was calculated for each participant at baseline and 6 months using the Australian Absolute Cardiovascular Disease Risk Calculator (National Vascular Disease Prevention Alliance, 2012). This calculator provides the likelihood of a cardiovascular event occurring within the next five years based on the individual's sex, age, systolic blood pressure, smoking status, total cholesterol, HDL cholesterol, and presence or absence of diabetes. Individuals with a risk score greater than 15% are considered to be high risk; those with scores between 10-15% are medium risk; and individuals with a risk score less than 10% are considered low risk.

3.9 Data analysis

Data were coded and analysed using SPSS version 22.0. Descriptive statistics were used to summarise participants' health and demographic characteristics. Comparisons between the intervention group and the control group were performed using univariate and multivariable methods. Outcome variables at baseline and 6 months post-test were used to test the hypotheses in association with the covariates and confounding variables. Independent and paired samples t-tests were applied to the continuous outcome variables, and Mann-Whitney U test and Wilcoxon Signed Rank test were applied to those variables exhibiting skewed distributions. To account for potential confounders, generalised estimating equation (GEE) models with exchangeable correlation structure were used to assess the repeated outcome variables over time. Normal GEE with identity link was applied to normally distributed continuous outcome variables, and gamma GEE with log link was applied to skewed continuous variables. All hypotheses were tested at the 0.05 significance level.

3.10 Summary of results

A total of 312 (77.8%) participants (151 intervention and 161 control) attended the clinic for post-test data collection and were included in the anthropometric analysis; 310 (77.3%) were included in the self-report analysis (151 intervention and 159 control), and 274 (68.3%) were included in the blood sample analysis (130 intervention and 144 control) after participants with incomplete data were removed from the sample. Upon completion of the study, the intervention group marginally increased their metabolic equivalent (MET) minutes of moderate intensity physical activity per week (p=0.049), and significantly improved fibre intake (p<0.001), fat intake (p=0.003), and vegetable serves per day (p=0.002) from baseline to post-test relative to the control group, after controlling for confounders (see **Publication 2** in Appendix A for full details). Significant improvements in triglyceride (-0.10 mM, p=0.002), total cholesterol (-0.09 mM, p=0.02), non-HDL cholesterol (-0.08 mM, p=0.02), waist circumference (-2.11 cm, p=0.03), waist-to-hip ratio (-0.01, p=0.04), weight (-0.70 kg, p=0.01), and body mass index (-0.20 kg/m^2, p<0.001) were also observed (see **Publication 3** in Appendix A for full details). Additionally, 15 less participants were classified *with* MetS and 8 less were classified as *at risk* of MetS at post-test, and a significant reduction in cardiovascular risk score (-0.82, p<0.001) relative to the control group was observed (see Table 3.6).

Table 3.6. Between- and within-group changes to MetS status and CVD risk scores (n=274)

Outcome	Intervention group (n=130)		p[1]	Control group (n=144)		p[2]	p[3]	p[4]
	Baseline	Post		Baseline	Post			
With MetS	66 (50.8%)	51 (39.2%)	0.03	77 (53.5%)	78 (54.2%)	0.69	0.72	0.02
At risk of MetS	64 (49.2%)	56 (43.1%)		67 (46.5%)	46 (31.9%)			
CVD risk: With MetS	8.54 (4.2)	7.44 (4.1)	<0.001	7.90 (4.05)	7.30 (3.9)	0.04	0.33	0.72
CVD risk: At risk of MetS	5.48 (3.5)	4.93 (3.2)	0.01	5.78 (3.6)	5.95 (3.7)	0.51	0.46	0.08
CVD risk: All	7.03 (4.1)	6.21 (3.9)	<0.001	6.90 (4.0)	6.66 (3.8)	0.30	0.96	0.02

[1] Chi-square or paired t-test between baseline and post-test for the intervention group
[2] Chi-square or paired t-test between baseline and post-test for the control group
[3] Chi-square or independent t-test between intervention and control groups at baseline
[4] Chi-square or independent t-test between intervention and control groups at post-test

Related publications:

2. **Blackford, K**., Jancey, J., Lee, A. H., James, A., Howat, P., & Waddell, T. (2016). Effects of a home-based intervention on diet and physical activity behaviours for

rural adults with or at risk of metabolic syndrome: a randomised controlled trial. *International Journal of Behavioral Nutrition and Physical Activity, 13*, 13. http://dx.doi.org/10.1186/s12966-016-0337-2. [Impact Factor 4.11]

3. **Blackford, K**., Jancey, J., Lee, A. H. James, A., Waddell, T., & Howat, P. (2016). Home-based lifestyle intervention for rural adults improves metabolic syndrome parameters and cardiovascular risk factors: A randomised controlled trial. *Preventive Medicine, 16*(89), 15-22. http://dx.doi.org/10.1016/j.ypmed.2016.05.012. [Impact Factor 2.893]

3.11 Process evaluation

Process evaluation is an essential requirement of reporting on public health research interventions and health promotion programs (Armstrong et al., 2008). Process evaluation provides useful information on how a successful intervention was conducted and how it can be replicated, and whether trial outcomes can be reproduced in a specific context (G. Moore et al., 2015). This is essential to identify the appropriateness of the intervention to the target group, and assesses the appropriateness and effectiveness of the research procedure. Process evaluation also assists with understanding the components of the intervention that were most effective in improving dietary and physical activity behaviours, and how these impact on health outcomes (Hartmann-Boyce et al., 2014).

The following components of the intervention were assessed as part of the process evaluation: implementation process and what was delivered (fidelity, dose, adaptations, and reach); participant responses to intervention interactions; and contextual or external factors influencing the intervention (G. Moore et al., 2015). Evaluation of program materials was conducted halfway through the intervention, and exit interviews were conducted post-intervention. This section addresses the following objectives:

2. Determine the effectiveness of strategies to recruit and retain the target group in a physical activity and dietary behaviour change intervention.
3. Assess the acceptability and appropriateness of the intervention strategies and resources for the target group.

3.11.1 Materials evaluation

Evaluation of the program materials (booklet, exercise chart, website) was conducted at the three-month point of the intervention using a brief online questionnaire (Appendix

H, Materials Evaluation). The questions were modified from those used for a previous study (Burke, Jancey, Howat, Lee, & Shilton, 2013). A subset of intervention participants with computer access (n=145) received an email link and were asked to comment on features of the program materials (booklet, exercise chart, and website) that they liked or disliked, by responding to open-ended questions and five-point Likert scales (e.g. not useful to useful, not very suitable to very suitable, not very eye-catching/attractive to very eye-catching/attractive).

3.11.2 Exit interviews

Sixteen intervention participants (8 completers and 8 non-completers) were purposefully selected to participate in exit interviews post-intervention. This sample size was based on a previous study (Burke et al., 2010) and the literature which suggests that saturation occurs within the first 12 interviews (Di Cicco & Crabtree, 2006). Participants were contacted by telephone and asked if they were willing to participate in a one-on-one interview with a trained researcher. The researcher followed an interview schedule (Appendix H, Exit Interview Schedule – Completers), which asked the participant to comment on their perceptions of the program overall, the program materials and strategies, and the motivational interviewing. In addition, the non-completers were asked the reasons for their withdrawal (Appendix H, Exit Interview Schedule – Non-Completers). Each interview took approximately 20 minutes.

3.11.3 Qualitative analysis

All qualitative data were transcribed within two weeks of interviewing. Data were coded and common themes were created. The information obtained was collated, presented thematically and supported by direct quotes from participants. Management of full transcripts and other text was facilitated by NVIVO. Participants' permission was obtained but they were not identified in transcripts.

3.11.4 Summary of results

After randomisation, 18% of participants withdrew from the intervention. Reasons provided included health issues, personal issues, lost interest or changed their mind, travelling, moved out of the area, and work commitments. The average number of motivational interview calls completed by participants who finished the six month intervention was three, with approximately one third (32%) completing between four to six calls. Most participants reported increased motivation for physical activity and

dietary improvements due to the program resources, which they reported to be useful, attractive, and suitable to people their age. Reasons for being involved in the program included wanting to address issues with weight, expecting health benefits, wanting the research results to benefit the community, and enjoying the challenge. Participants also liked the support they received, saying it was motivating and that it helped with overcoming barriers. Suggestions to improve the program included face-to-face delivery mode, more regular feedback, and more incentives to complete the program. **Publication 4** (Appendix A) provides the full process evaluation results.

4. **Blackford, K**., Lee, A. H., James, A., Waddell, T., Hills, A. P., Anderson, A. S., Howat, P., & Jancey, J. (2016). Process evaluation of the Albany Physical Activity and Nutrition (APAN) program, a home-based intervention for metabolic syndrome and associated chronic disease risk in rural Australian adults. *Health Promotion Journal of Australia.* http://dx.doi.org/10.1071/HE16027. [Impact Factor 1.231]

4.0 Discussion

This thesis describes the development, implementation, and evaluation of a home-based behaviour change intervention in a rural setting. The intervention was evaluated via a large RCT which demonstrated effectiveness in improving dietary and physical activity behaviours, improving chronic disease risk factors, and reducing MetS prevalence in older rural adults. This study also provided a link between intervention elements and outcomes via rigorous process evaluation, highlighting the most effective and preferred strategies and delivery modes for the high risk target group. The following section reflects on the study objectives and expands on the strengths and limitations that were discussed in each of the publications presented as part of this thesis.

4.1 Reflection on the study objectives

4.1.1 Objective 1

The purpose of objective 1 was to design and implement a RCT of a home-based intervention to improve the physical activity and dietary behaviours of adults aged 50-69 years *with* or *at risk* of MetS, residing in a rural community (**Publication 1**, Appendix A). Behaviour change interventions addressing MetS and related chronic diseases in rural areas are under-researched, particularly in an Australian context. These underserviced high risk groups are in need of such interventions, considering the increased prevalence of modifiable risk factors and burden of disease compared to metropolitan areas. A small number of behaviour change interventions have been designed and implemented for rural adults *with* or *at risk* of MetS globally. Such programs have mostly been adapted from large diabetes prevention studies including the Diabetes Prevention Program (Diabetes Prevention Program Research Group, 2002), the Finnish Diabetes Prevention Study (Tuomilehto et al., 2001), and the GOAL Lifestyle Implementation Trial (Absetz et al., 2007). Study locations for rural interventions have included the USA (Perri et al., 2008; Pullen et al., 2008; Vadheim et al., 2010; Weinstock et al., 2013), Canada (Stuckey et al., 2011), Korea (Oh et al., 2008), and one study which was conducted in rural Australia (Kilkkinen et al., 2007). Considering the lack of research in this area, the present study contributes to the knowledge of behaviour change interventions for those *with* and *at risk* of MetS in the rural Australian context.

The evidence on the effectiveness of lifestyle interventions on health outcomes, particularly MetS, T2DM and CVD morbidity and mortality is well established. The

need for effective behaviour change techniques for initiation and maintenance of dietary and physical activity behaviours to achieve such health outcomes in various population groups is also well-established. Interventions typically involve individual counselling by trained health professionals, which is a limitation for areas with high levels of chronic disease prevalence and limited access to health services (Oldenburg, Absetz, Dunbar, Reddy, & O'Neil, 2011). Considering the increased morbidity and mortality associated with poor diet, physical inactivity and overweight/obesity in rural and remote areas of Australia, it is worthwhile determining the most effective behaviour change techniques to support improvements in MetS prevalence and related chronic disease incidence in such high-risk individuals.

The intervention study investigated the effectiveness of dietary and physical activity behaviour change techniques for adults living in rural Australia. Techniques such as goal setting, self-monitoring and regular feedback can be enhanced by motivational interviewing (Artinian et al., 2010), and should be based on behavioural theory. The combination of motivational interviewing and Self-Determination Theory for the present study recognised the value of autonomous motivation in the facilitation of behaviour change (Patrick & Williams, 2012). Additionally, the combination of primary (dietary and physical activity behaviours) and secondary outcomes (biomedical and other health measures) enabled evaluation of the effectiveness of the intervention and its impact on health outcomes.

Process evaluation was also incorporated in the study design, to ensure components of the intervention that were most effective and acceptable were reported on. Process evaluation is an important consideration for behaviour change interventions, yet is often underreported. This combination of measures included in the study design allowed for rigorous evaluation across a number of study objectives.

4.1.2 Objective 2

The purpose of Objective 2 was to determine the effectiveness of strategies to recruit and retain the target group in a physical activity and dietary behaviour change intervention (**Publication 4**, Appendix A). By using strict inclusion criteria across several recruitment stages, self-selection bias was minimised which enhanced internal validity. Although this process was resource intensive and time consuming, it did remove the issues associated with motivated individuals responding to general promotion of the study. Recruitment stage one utilised two combined methods:

telephone calls via the CATI system, and a postcard drop to all dwellings in the eligible area informing them of the incoming call and the study aims and objectives. Participants were also given the option to contact researchers if they were interested in participating. CATI statistics were recorded (as presented in section *3.6.1 Screening stage one*); however, information was not collected to determine the usefulness of the postcards. Considering the wide reach and potential cost reduction associated with using postcards as a recruitment method (Iredell et al., 2004), it would be worthwhile recording such information in future studies and reporting on the effectiveness of postcards versus cold calling.

Recruitment stage two highlighted the usefulness of the AUSDRISK instrument for identifying individuals *with* and *at risk* of MetS, which is an alternative to taking blood samples if the latter is impractical or too costly for large samples. A number of studies have used a diabetes risk assessment tool to identify and recruit participants (Nilsen, Bakke, & Gallefoss, 2011), such as the Finnish Diabetes Risk Score (Jaana. Lindström & Tuomilehto, 2003) and AUSDRISK (Chen et al., 2010). The use of such tools for identifying cases of MetS and MetS risk is under researched; the present study therefore adds to the literature in this area. Additionally, using the IDF MetS criteria for recruitment stage three had an advantage over other definitions, due to the use of a simple and inexpensive waist measurement as the necessary diagnostic requirement (Zimmet et al., 2005).

Upon completion of recruitment stage three, 401 participants were randomised into intervention or control group. Prior to post-test data collection, 17% of participants withdrew from the study and a further 5% were lost to follow-up across both groups, giving an overall attrition rate of 22% which is slightly higher than other health behaviour change trials (Crutzen, Viechtbauer, Spigt, & Kotz, 2014). Although differential attrition was avoided due to no observed differences between the intervention and control groups after withdrawals and losses to follow-up, minimising overall attrition is a desirable outcome in intervention research to enhance internal validity (Dumville, Torgerson, & Hewitt, 2006). Methods to reduce attrition in such studies include readiness-to-change assessment (Ali, Echouffo-Tcheugui, & Williamson, 2012) and the provision of participant baseline chronic disease risk and health status prior to beginning the intervention (Groeneveld, Proper, van der Beek, Hildebrandt, & van Mechelen, 2009). Understanding readiness to change prior to

beginning the intervention is beneficial because it allows for matching between strategies/treatments and participants' motivation levels (Cresci & Rotella, 2009). For example, if a participant is ready to lose weight, dietary and physical activity behaviour change techniques can be initiated; whereas a participant who is not at the same stage of change should have barriers addressed prior to further intervention. The attrition rate of the present study may have been reduced if this strategy was employed as part of the intervention. Additionally, if participants were provided with their chronic disease risk scores and other health indicators at baseline, motivation levels may have increased.

4.1.3 Objective 3

The purpose of Objective 3 was to assess the acceptability and appropriateness of the intervention strategies and resources for the target group (**Publication 4**, Appendix A). Interventions that rely on behaviour change often leave the participant feeling responsible for their own behaviour and its consequences, such that if an intervention is not assisting them with their desired outcomes they may not return for follow-up measurements (Crutzen et al., 2014). Similarly, participants in the intervention group often have higher expectations of the program than the control group who are on a waiting list, and when their expectations are not met they are more likely to withdraw (Crutzen et al., 2014). Considering this, assessing the acceptability and appropriateness of the intervention as well as reasons for withdrawal can assist with reducing attrition and potential bias in future studies.

Delivery mode is an important consideration for rural dietary and physical activity behaviour change interventions. Of the studies conducted in the USA, Canada, Korea and Australia, the majority utilised group or individual face-to-face delivery modes (Kilkkinen et al., 2007; Oh et al., 2008; Stuckey et al., 2011; Vadheim et al., 2010), with one using a combination of face-to-face and remote delivery (Perri et al., 2008) and some using remote delivery only (Pullen et al., 2008; Weinstock et al., 2013). Considering the similarities in effectiveness across the delivery modes, it can be suggested that using remote delivery is less resource-intensive, more wide-reaching and therefore more suitable for rural areas with limited access to resources and services. The present study used a combination of telephone and online delivery modes, with process evaluation revealing that the majority of participants used the printed materials but not the online resources, and most did not complete all of the motivational interviewing sessions via telephone. Some of the participants reported that they would have preferred

a face-to-face component included in the intervention. The reach and scalability would be reduced by including a face-to-face component, so investigating alternative options to replace the face-to-face experience is warranted. Video calling could be investigated for rural areas, which may also improve participation in the motivational interviewing component of the intervention. Delivery via mobile phone technology is also worth investigating further.

Considering the limited use of the online resources and tools by APAN participants, further investigation into acceptability of the delivery mode for the target group is warranted. Design of the online components could be improved to ensure participation is maintained and withdrawal is kept to a minimum. Combining effective behaviour change techniques with persuasive website design elements, such as self-monitoring tools, social support via blogs, and reminders, may improve overall use of the delivery mode (Short, Rebar, Plontikoff, & Vandelanotte, 2015). The present study did incorporate these elements; however, there may have been design flaws that made the tools unattractive and burdensome for participants. Other important considerations for online intervention components to increase exposure and improve retention are more frequent updates of websites and tools (Brouwer et al., 2011) and the use of tailored feedback (Brouwer et al., 2010; Schulz et al., 2014), which is another effective behaviour change technique that could be explored for the target group.

Addressing recruitment, retention and participation issues has important implications for future studies and programs, particularly when allocating scarce funds to prevention programs. Future programs should consider both the number of participants required, the time required to recruit, and the number of staff to be involved in the process (Carroll et al., 2011). Any such constraints will affect the recruitment and retention methods that can be used. Comparing the process evaluation results of the present study to those of two similar rural interventions, the Greater Green Triangle Diabetes Prevention Project and the Montana Cardiovascular Disease and Diabetes Prevention Program (Reddy et al., 2011), provides a number of recruitment and retention recommendations for future interventions. These include using direct referrals from primary care givers rather than attempting to contact individuals in their homes; providing more incentives to complete the program, including the potential improvement in health status; ensuring long-term as well as short term goals are set by participants to enhance long-term commitment; and acknowledging and accounting for

the impact of depression on participation. The latter was not included in the present study, which may be a useful tool to include in future interventions for the target group to minimise attrition. Overall assessment of the processes of the present study suggests internal validity was maintained, which was further assessed by controlling for confounders when examining the changes to primary and secondary outcome measures (Objectives 4 & 5).

4.1.4 Objective 4

The purpose of Objective 4 was to assess at post-test the change in physical activity and dietary behaviours of intervention participants relative to the control group (**Publication 2**, Appendix A), which were the primary outcome measures of the study. As suggested by the literature, the most effective interventions for MetS are combined diet and physical activity modifications delivered via behaviour change techniques. The present study used a combination of techniques that are known to be effective for influencing changes to dietary and physical activity behaviours, such as goal setting, self-monitoring, frequent contacts, and motivational interviewing (Artinian et al., 2010; Michie et al., 2009) to determine their effectiveness for rural adults with or at risk of MetS using remote delivery modes. As confirmed by the process evaluation, intervention compliance and acceptability was adequate to ensure primary outcome measures were improved. These changes included significant improvements in fat, fibre, and vegetable intake, and modest improvement in moderate intensity physical activity for the intervention group after controlling for confounders, which suggest that the combination of behaviour change techniques and delivery modes is effective for changing health behaviours of such high risk groups.

Significant improvements were not observed for a number of behaviours in the present study. These include walking, strength training, sitting/sedentary behaviour, and fruit intake. Given the health benefits of improvements in these behaviours for adults *with* and *at risk* of MetS, particularly strength training (Minges et al., 2012) and reduced sitting time (Gardiner et al., 2011), it is worthwhile determining strategies to address these gaps. It could be suggested that the measurement instruments were not able to accurately detect changes. Over reporting of physical activity and under-reporting of sedentary behaviour using self-report instruments such as IPAQ-SF is a recognised issue; however, it should be acknowledged that these instruments are nonetheless useful for repeated measures (P. Lee, Macfarlane, Lam, & Stewart, 2011), thus can reliably

detect behaviour change. Future studies could incorporate objective measures such as pedometers which are useful for step counts; however, it should be noted that these are not ideal for control groups given the tendency to motivate behaviour change via direct feedback to the participant (Strath et al., 2013). Other options include accelerometers to measure physical activity intensity and inclinometers to measure sedentary behaviour, which can be difficult and expensive to administer in large studies (Matthews, Hagströmer, Pober, & Bowles, 2012).

4.1.5 Objective 5

The purpose of Objective 5 was to assess at post-test the change in body composition, MetS parameters, and cardiovascular risk factors for the intervention group relative to the control group (**Publication 3**, Appendix A). The significant improvements in lipid profile and body composition for the intervention group of the present study indicates that improvements in dietary and physical activity behaviours have beneficial effects on health outcomes. It is well established that all of the clinical markers of MetS can be improved with positive changes to diet and physical activity behaviours (Bassi et al., 2014). Physical activity is an effective treatment for individuals with metabolic abnormalities associated with insulin resistance (Blaha et al., 2008). Reduced sitting time (Gardiner et al., 2011) and increased strength training (Minges et al., 2012) are also important for MetS management and chronic disease prevention (Gardiner et al., 2011). Weight loss can reduce oxidative stress and improve blood-lipid regulation and other MetS components (Aucott, Gray, Rothnie, Thapa, & Waweru, 2011; Blaha et al., 2008). Weight loss via diet and physical activity modifications therefore plays an important role in prevention and management of MetS and related chronic diseases (Mecca et al., 2012; Prasad et al., 2012). Considering the limitations of self-report instruments for dietary and physical activity behaviour change, the inclusion of biomarkers as secondary outcome measures provides more objective evidence of intervention effectiveness.

4.1.6 Objective 6

The purpose of Objective 6 was to assess the change in MetS status and CVD risk scores at post-test relative to the control group. The APAN study addressed MetS as one entity, in addition to dealing with individual CVD risk factors and MetS parameters as recommended by the literature (Gami et al., 2007). MetS is an effective indicator of increased lifetime risk of T2DM and CVD. Adoption of the program led to a significant

reduction in the number of intervention group participants with MetS compared to the control group, with 18% of intervention participants *with* or *at risk* of MetS at baseline improving their classification upon completion of the study. Significant improvement in MetS parameters and other CVD risk factors also led to significant improvement in overall CVD risk scores for the intervention group. CVD risk equations were developed before the obesity epidemic and therefore do not account for excess body fat or markers of relative weight such as BMI or waist circumference, and their influence on CVD risk (Han & Lean, 2006). MetS identification is therefore a useful additional tool to reduce the burden of chronic disease due the importance of identifying central obesity in addition to other CVD risk factors, which is an important target for early lifestyle intervention (Blaha et al., 2008). These findings demonstrate the effectiveness of the 6 month home-based diet and physical activity intervention to potentially reduce future cardiovascular events.

4.2 Study strengths

The present study acknowledged the poorer health outcomes in older rural Australian adults, via targeted screening and intervention for behavioural and biomedical risk factors for MetS, T2DM and CVD. The study strengths are highlighted in this section.

- Identifying individuals both *at risk* and *with* MetS allowed for primary and secondary prevention measures to be implemented and rigorously evaluated via a RCT. The findings indicate that it is worthwhile intervening at both levels to prevent/delay the onset of T2DM and CVD, and allows for a greater number of high risk individuals to be identified.
- Using the IDF MetS definition to identify individuals *at risk* and *with* MetS ensured that central obesity was a minimum requirement for inclusion in the study. This acknowledged the importance of obesity as a risk factor for MetS and related chronic disease, in addition to poor diet, physical inactivity and sedentary behaviour.
- The study design incorporated both primary and secondary outcome measures, which allowed for assessment of changes to important health outcomes as a result of behaviour change. The key to addressing MetS and chronic disease risk is effective behaviour change, and as such, dietary and physical activity behaviour change should be included as a primary outcome measure.
- The study design included rigorous process evaluation, which is typically underreported in RCTs. This allowed for assessment of recruitment methods and

intervention compliance and acceptability, which enhanced internal validity. Process evaluation also determined the most effective intervention components and behaviour change techniques that may have influenced primary and secondary outcome measures. These generalisability elements are necessary to guide dissemination of findings and enhance external validity (Laws, St George, Rychetnik, & Bauman, 2012), and reduce the risk of type III error.

- Motivational interviewing was a key component of the present study, and as such, autonomous motivation was promoted to enhance the effectiveness of behaviour change techniques. Prescribing intervention components would have likely resulted in less sustainable behaviour change; therefore supporting participants with goal setting and encouragement of self-monitoring was enhanced by motivational interviewing.

4.3 Study limitations

Study limitations are highlighted in this section.

- The intervention duration was ample for adequate behaviour change to occur; however, it should be acknowledged that the findings do not highlight the effects of the intervention in the longer term. Sustained behaviour change can be difficult to achieve for many health issues and target groups, particularly for dietary and physical activity behaviours. Follow-up assessments post-intervention are useful for evaluating the long-term effects of behaviour change interventions.
- As previously discussed, self-report instruments have their limitations for accurately measuring dietary and physical activity behaviours; however, they are useful for repeated measures (P. Lee et al., 2011). Additionally, using objective biomarkers as secondary outcome measures can reduce potential measurement error (Neuhouser et al., 2013; Subar et al., 2015), and allows for intervention effectiveness to be adequately determined.
- Intention-to-treat analysis was not performed in the present study; analysis was performed on available cases. This may have resulted in biased estimates of treatment effects (Abraha et al., 2015); however, it should be noted that this does not always accurately estimate the clinical effectiveness of trials (Hernán & Hernández-Díaz, 2012). Per protocol analysis can more accurately assess the effect of treatment based on intervention adherence/compliance (Hernán & Hernández-Díaz, 2012).

However, this was not possible for the present study because process evaluation data were not collected for all participants.

- Cost-effectiveness analysis was not included in the present study, which would have allowed for economic issues to be highlighted that may have implications for future interventions (Green & Glasgow, 2006). However, sophisticated economic analyses were beyond the scope and resources of the present study. Including cost-effectiveness analysis in future interventions can improve external validity (Laws et al., 2012).

5.0 Recommendations

The findings of the present study highlight a number of areas to be considered when developing, implementing and evaluating interventions for rural adults who are at increased risk of developing chronic disease. Recommendations for future work are provided in this section.

Recommendation 1: Follow-up data collection should occur to assess the long-term effectiveness of the intervention in combination with a booster intervention.

- Maintenance of dietary and physical activity behaviour change is more likely to occur in interventions that are longer than 24 weeks in duration (Fjeldsoe, Neuhaus, Winkler, & Eakin, 2011). Reversal of metabolic syndrome remains an important mechanism for chronic disease prevention; however, the long-term therapeutic value is uncertain because of limited information on the benefit of the intervention beyond the period of the trial (Dunkley et al., 2012). A systematic review of long-term lifestyle interventions to prevent weight gain reported that few studies followed up participants for a significant period of time, and few were powered to detect differences in morbidity (T. Brown et al., 2009). Gaps in the evidence-base identified by the authors necessitate recommendations for future interventions to be sufficiently powered to detect clinical changes and incorporate longer-term follow-up (T. Brown et al., 2009). Future studies should also investigate both the determinants of behaviour change initiation and maintenance (Fjeldsoe et al., 2011).

Recommendation 2: Cost-effectiveness analysis should be conducted in future behaviour change interventions targeting rural adults at risk of chronic disease.

- A key focus of the Australian health system is to improve health outcomes via better prevention and management of chronic diseases (Australian Institute of Health and Welfare, 2014). A key challenge will be dealing with the ageing population and the impact of lifestyle-related chronic disease (Australian Institute of Health and Welfare, 2014). It is therefore imperative that research and public policy efforts focus on more cost-effective and timely lifestyle interventions for diabetes and obesity (Sherwin & Jastreboff, 2012). Cost-effectiveness is determined by long-term health benefits rather than the direct cost of treating chronic disease; therefore intervention research should focus on sustainable interventions in real-world settings

(Norris, Kansagara, Bougatsos, & Fu, 2008). Despite the clinical value of large studies that incorporate intensive lifestyle programs, subsequent questioning of cost-effectiveness highlights the need to evaluate less expensive interventions in the long term (Dunkley et al., 2012). Meta-analysis of MetS trials has highlighted the need for future trials to provide information on long-term clinical outcomes and data on cost-effectiveness (Dunkley et al., 2012).

Recommendation 3: Implementation and evaluation of the intervention in different settings with more substantial resourcing, such as primary care, should occur.

- Traditionally, general practitioners often treat individual components of MetS with drug therapy, rather than managing the syndrome as a whole (Kaur, 2014). This may be due to the belief that it is more efficacious to prescribe medication for hypertension, hyperglycaemia or dyslipidaemia rather than working towards a longer term strategy to increase physical activity, improve dietary intake and lose excess weight as a means to improve glycaemic control and lipid profiles (Kaur, 2014). The ability of the APAN intervention to reduce the prevalence of MetS supports lifestyle interventions as an effective alternative to more medicalised treatment methods, and one that general practitioners could adopt as part of their usual practice (Binns et al., 2016). This would also address recruitment issues identified in the present study, by removing the requirement for cold calling and the costs associated with this method.

Overall, the evidence generated by the present study supports the notion that health status would be improved into older age if people maintained healthy dietary and physical activity behaviours across the lifespan. The importance of health promotion, particularly primary prevention, to encourage and empower people of all ages to adopt and maintain healthy behaviours before the development of chronic disease should not be ignored. The challenge of reversing T2DM and CVD in older age further highlights the need for greater primary prevention efforts, particularly in high risk groups and settings. Unfortunately, the lack of resources from national governments to support such ongoing preventive health promotion (Binns, Howat, & Jancey, 2014) means there is an ongoing requirement to intervene later in life to at least moderate the effects of unhealthy lifestyle behaviours, particularly in rural areas.

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Appendices

Appendix A: Thesis publications

This appendix includes the following publications:

1. **Blackford, K.**, Jancey, J., Lee, A. H., James, A., Howat, P., Hills, A. P., & Anderson, A. S. (2014). A randomised controlled trial of a physical activity and nutrition program targeting middle-aged adults at risk of metabolic syndrome in a disadvantaged rural community. *BMC Public Health*, *15*, 284. http://dx.doi.org/10.1186/s12889-015-1613-9. [Impact Factor 2.26]

2. **Blackford, K**., Jancey, J., Lee, A. H., James, A., Howat, P., & Waddell, T. (2016). Effects of a home-based intervention on diet and physical activity behaviours for rural adults with or at risk of metabolic syndrome: a randomised controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, *13,* 13. http://dx.doi.org/10.1186/s12966-016-0337-2. [Impact Factor 4.11]

3. **Blackford, K**., Jancey, J., Lee, A. H. James, A., Waddell, T., & Howat, P. (2016). Home-based lifestyle intervention for rural adults improves metabolic syndrome parameters and cardiovascular risk factors: A randomised controlled trial. *Preventive Medicine, 16*(89), 15-22. http://dx.doi.org/10.1016/j.ypmed.2016.05.012. [Impact Factor 2.893]

4. **Blackford, K**., Lee, A. H., James, A., Waddell, T., Hills, A. P., Anderson, A. S., Howat, P., & Jancey, J. (2016). Process evaluation of the Albany Physical Activity and Nutrition (APAN) program, a home-based intervention for metabolic syndrome and associated chronic disease risk in rural Australian adults. *Health Promotion Journal of Australia* (Online Early). http://dx.doi.org/10.1071/HE16027. [Impact Factor 1.231]

Publication 1: A randomised controlled trial of a physical activity and nutrition program targeting middle-aged adults at risk of metabolic syndrome in a disadvantaged rural community.

This publication addresses Objective 1:

1. To design and implement a RCT of a home-based intervention to improve the physical activity and dietary behaviours of adults aged 50-69 years *with* or *at risk* of MetS, residing in a rural community.

Citation:

Blackford, K., Jancey, J., Lee, A. H., James, A., Howat, P., Hills, A. P., & Anderson, A. S. (2014). A randomised controlled trial of a physical activity and nutrition program targeting middle-aged adults at risk of metabolic syndrome in a disadvantaged rural community. *BMC Public Health, 15*, 284. http://dx.doi.org/10.1186/s12889-015-1613-9.

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BMC Public Health

STUDY PROTOCOL Open Access

A randomised controlled trial of a physical activity and nutrition program targeting middle-aged adults at risk of metabolic syndrome in a disadvantaged rural community

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Abstract

Background: Approximately 70% of Australian adults aged over 50 are overweight or obese, with the prevalence significantly higher in regional/remote areas compared to cities. This study aims to determine if a low-cost, accessible lifestyle program targeting insufficiently active adults aged 50-69 y can be successfully implemented in a rural location, and whether its implementation will contribute to the reduction/prevention of metabolic syndrome, or other risk factors for type 2 diabetes, and cardiovascular disease.

Methods/Design: This 6-month randomised controlled trial will consist of a nutrition, physical activity, and healthy weight intervention for 50–69 year-olds from a disadvantaged rural community. Five hundred participants with central obesity and at risk of metabolic syndrome will be recruited from Albany and surrounding areas in Western Australia (within a 50 kilometre radius of the town). They will be randomly assigned to either the intervention (n = 250) or wait-listed control group (n = 250). The theoretical concepts in the study utilise the Self-Determination Theory, complemented by Motivational Interviewing. The intervention will include a custom-designed booklet and interactive website that provides information, and encourages physical activity and nutrition goal setting, and healthy weight management. The booklet and website will be supplemented by an exercise chart, calendar, newsletters, resistance bands, accelerometers, and phone and email contact from program staff. Data will be collected at baseline and post-intervention.

Discussion: This study aims to contribute to the prevention of metabolic syndrome and inter- related chronic illnesses: type 2 diabetes mellitus, cardiovascular disease, and some cancers; which are associated with overweight/obesity, physical inactivity, and poor diet. This large rural community-based trial will provide guidelines for recruitment, program development, implementation, and evaluation, and has the potential to translate findings into practice by expanding the program to other regional areas in Australia.

Trial registration: Australian and New Zealand Clinical Trials Registry [ACTRN12614000512628, registration date 14th May 2014].

Keywords: Metabolic syndrome, Nutrition, Physical activity, Middle age, Obesity, Regional/remote, Disadvantaged area, Intervention, Health promotion, Chronic disease prevention

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Background

In Australia, approximately 70% of adults aged over 50 are overweight or obese, with the prevalence significantly higher in rural areas compared to metropolitan areas [1]. The prevalence of obesity has increased 8.8% in the last 17 years with poor diet and physical inactivity likely causes [2]. Overweight/obesity coupled with advancing age increases the risk of metabolic syndrome [3], which is a cluster of abnormalities that are well documented risk factors for type 2 diabetes mellitus and cardiovascular disease [4]. These include central obesity, elevated triglyceride levels, reduced high-density lipoprotein (HDL)-cholesterol, raised blood pressure, and raised fasting plasma glucose [5].

It is estimated that approximately 25% of the Australian adult population has metabolic syndrome [3]. Prevalence is age-dependent, with the incidence rising rapidly in those of middle-age [6,7]. The relative risk of type 2 diabetes mellitus in middle-aged adults and cardiovascular disease in men has been shown to increase among those with metabolic syndrome [8]. It is imperative that overweight/obese individuals, particularly those with metabolic syndrome, are identified to ensure risk factors are addressed through lifestyle modifications and management, thereby contributing to the reduction of type 2 diabetes mellitus, cardiovascular disease, and premature death [3,6].

The prevalence of overweight/obesity has been rising among middle-aged adults living in harder to reach and often neglected rural locations of Australia [2]. These people are more likely to be overweight/obese compared with adults living in cities [9], leading to higher levels of disease risk factors. The health profile of the Great Southern region of Western Australia (location of the study area – Albany) highlights the need for greater access to health services and programs to improve the health of residents. The majority of adults (89%) do not eat the recommended daily serves of vegetables, and almost half (47.8%) do not eat adequate amounts of fruit [10], while half (50.1%) of adults do not achieve the recommended levels of physical activity [10]. In addition, Albany scores 987.4 on the Socio-Economic Indexes for Areas, indicating relative disadvantage (<1000) [1]. More disadvantaged areas have higher prevalence of risk factors and reported ill health compared with less disadvantaged areas [1].

Currently, there is a gap in the knowledge for implementing effective home-based lifestyle interventions targeting chronic disease risk reduction in disadvantaged rural areas such as Albany. This paper describes the protocol of a randomised controlled trial (RCT) that aims to address metabolic syndrome and overweight/obesity by improving the physical activity and nutrition behaviours of insufficiently active middle-aged people residing in the rural town of Albany in Western Australia. It is hypothesised that by the end of the 6-month RCT, the intervention groups compared to the control groups will show significant improvements in insulin sensitivity and lipid profile, as well as a number of anthropometric, physical activity and nutrition outcomes; thereby reducing the risk of metabolic syndrome and chronic diseases.

Methods

Study design

This 6-month RCT will identify and recruit insufficiently active adults aged 50 to 69 with central obesity, residing in Albany, Western Australia, to participate in a home-based physical activity, nutrition, and healthy weight management intervention. Additional file 1: Figure S1 summarises the study design. A total of 500 participants with or at risk of metabolic syndrome will be recruited and randomised into intervention (n = 250) and wait-listed control (n = 250) groups. Data will be collected from both groups at baseline and 6 months to assess changes in outcome measures. Ethical approval of the study has been obtained from the Human Research Ethics Committee of Curtin University (HR149_2013). All participants will be informed of the research aims and objectives, and that confidentiality will be maintained throughout the study. Information and consent forms will be provided prior to entry into the RCT and participants will be free to withdraw from the program at any time.

Recruitment

Study participants aged 50–69 years and insufficiently active (less than 150 minutes of moderate physical activity per week) [11] will be recruited. Additional criteria for metabolic syndrome is based on assessing the following International Diabetes Federation (IDF) metabolic syndrome criteria [5]: central obesity (waist circumference >94 cm men or >80 cm women [Europids, Sub-Saharan Africans, Eastern Mediterranean, Middle East]; >90 cm men or >80 cm women [South Asians, Chinese, Japanese]); plus any two of: raised triglyceride level (>1.7 mM, or treatment for this); reduced HDL-cholesterol (<1.03 mM in males and <1.29 mM in females, or treatment for this); raised blood pressure (systolic ≥130 mmHg or diastolic ≥85 mmHg, or treatment of previously diagnosed hypertension); raised fasting plasma glucose (≥5.6 mM). However, only one instead of two of the latter four conditions needs to be satisfied to increase the potential pool of at risk participants. Identifying participants at risk of developing metabolic syndrome will enable appropriate intervention to be implemented, with the aim of preventing the onset of the syndrome and potential for type 2 diabetes and cardiovascular disease [12].

The following exclusion criteria will apply: previous diagnosis of diabetes mellitus (other than gestational

diabetes); receiving treatment to lower blood glucose; on a weight loss diet or having weight fluctuations of >5% within the past 6 months; involvement in another physical activity and/or nutrition program; or a partner/individual residing in the same household as another participant already recruited for the study (to avoid contamination).

After the initial screening (n = 1000), it is expected that 625 participants will be eligible to join the study. Allowing for a subsequent 5% withdrawal rate and another 15% loss to follow-up, a final sample size of n = 250 intervention and n = 250 controls is anticipated, with quota sampling to ensure equal numbers of males and females. These figures are based on the pilot recruitment and data collection phase of the study.

Procedure

Additional file 1: Figure S1 summarises the study design. Screening will occur in three stages and will be staggered to accommodate limited resources and staffing.

Screening stage 1

Potential participants will be initially screened by telephone via the Computer Assisted Telephone Interview system, which is an efficient method of recruitment used for a previous study [13]. During the initial contact, the purpose of the study will be explained and the caller will determine whether the individual meets the initial screening criteria. This will incorporate a number of diabetes risk factors based on AUSDRISK, an Australian type 2 diabetes mellitus risk assessment tool utilising anthropometric, lifestyle, and demographic measures [14]. This simple and reliable questionnaire will screen those at high risk of developing type 2 diabetes mellitus (risk score ≥12). Findings from our pilot data indicate that in order to achieve the required sample size, 1000 people with high risk scores will require to be screened for potential inclusion into the study.

Screening stage 2

After stage 1, participants meeting the initial selection criteria and indicating an interest in the study will be sent information explaining the home-based intervention project, their rights, and confidentiality details. An appointment will then be made for them to attend a central location in Albany for anthropometric measurements, blood pressure readings, and completion of a questionnaire.

Screening stage 3

Participants with confirmed central obesity based on screening stage 2 results will then be asked to attend a blood collection centre in Albany for the collection of a fasting blood sample (triglycerides, glucose, cholesterol) to determine whether they are at risk of metabolic syndrome.

Once eligibility criteria are determined, random assignment to intervention and control groups will occur, with quota sampling for gender. Suburbs and postcodes will be ranked according to the Socio-Economic Index for Areas and equal numbers of low and high scoring suburbs and postcodes will be allocated to each group. Intervention participants will be briefed about the purpose of the control group and the importance of refraining from communication about the program with control group members during the intervention period. They will receive the intervention materials and their AUSDRISK scores to emphasise the relevance of the program and the need for compliance to the lifestyle intervention.

Intervention

As part of this 6-month home-based intervention, each participant will be provided with a package designed to educate, motivate, and support improvement in nutrition and levels of physical activity through goal setting, based on the principles of Self-Determination Theory and Motivational Interviewing [15,16]. The program will empower individuals to self-manage and monitor their health behaviours and weight within their own environment (home). The approach will take particular care to emphasise the importance of regular self-weighing which is widely associated with greater weight loss (showing a 1 to 3 BMI unit advantage over individuals who do not self-weight frequently) [17]. In addition, frequent self-weighing is an important behavioural mediator in weight loss maintenance [18].

The intervention program is based on recent successful physical activity and nutrition programs (Physical Activity & Nutrition for Seniors [PANS] and the Perth Active Living Seniors [PALS]) specifically designed for older adults by the research team [19,20]. It will be adapted for the younger age group and the rural context. The intervention is safe, accessible, and low cost. Participants will commence it at a low level of physical activity, with aerobic, strength and flexibility components commensurate to the fitness level of each individual. The educational materials will provide illustrations and tips on how to perform exercises safely. The physical activity component will use accelerometers to measure programmed and incidental physical activity at baseline and post-test for the intervention group only, with graphical feedback provided to participants at baseline. The nutrition component will consist of suggested meal plans, recipes, and tips on healthy eating, encouraging a higher consumption of fruit/vegetables and fibre while reducing intake of saturated fat and sugar.

Research assistants will assist with the delivery of intervention resources and liaise with the participants to provide support and to monitor their goal setting. These assistants will receive a training manual including guidelines for diet

and physical activity adherence, and will undergo training in Motivational Interviewing techniques [21]. They will make telephone contact with participants at weeks 3, 6, 12, 18 and 24 of the intervention. Additionally, follow-up emails will be used, and participants will have the option to contact the research assistant they have been allocated to.

Program resources

Booklet

Participants will receive a booklet designed to educate and motivate improvements in nutrition and physical activity. Content will be developed from the PANS materials [13] and adapted for a rural context. Materials will be based on the Australian Dietary Guidelines [22] and Australia's Physical Activity and Sedentary Behaviour Guidelines [11]. Participants will be required to set their own goals for the duration of the intervention to ensure the program suits their individual needs.

Exercise chart, calendar, and resistance bands

The calendar will support participants' goal setting by providing a resource for their planning, and recording their physical activity and eating habits, and will supplement the program booklet as a quick and convenient reference. Participants in the intervention group will be provided with a resistance band to use for strength training exercises. Instructions and photographs demonstrating safe and correct use will be summarised in an exercise chart [13].

Nutrition panel wallet cards

The wallet cards will provide assistance to participants when choosing healthy food options in a supermarket setting. The card will include information usually found on nutrition panels such as saturated fat, sugar, fibre, salt, common names for nutrients, and amounts per serve and per 100 grams considered to be healthy options.

Website

An online component will be developed to provide materials in electronic format to the intervention group. Pages will include nutrition and physical activity information and links, a blog for program news and updates, and a daily and weekly progress tracker enabling participants to log and track their physical activity and nutrition behaviours and monitor their weight. The website will be password protected, allowing access by the intervention group only during the study period.

Newsletter

A bi-monthly newsletter will be sent to intervention participants via the website, email, and post (for those without internet), to maintain participation. Previous research has shown that a 1–2 page newsletter containing health information is usually positively received in program of this nature [23,24].

Control group

The control group (n = 250) will be placed on a 'waitlist' to receive the intervention after they compete the post-test data collection. This group will not receive their risk scores; however will be informed they are eligible for the study after the first group have completed their program. Previous interventions have adopted this method of wait listing the control group [25,26].

Outcome measures

Table 1 summarises measurement of each outcome variable.

Metabolic syndrome status will be determined using the IDF criteria [5]. Participants satisfying the full criteria will be classified as having metabolic syndrome; whereas those with central obesity (waist circumference >94 cm men or >80 cm women [Europids, Sub-Saharan Africans, Eastern Mediterranean, Middle East]; >90 cm men or >80 cm women [South Asians, Chinese, Japanese]) plus any one of: raised triglyceride level (>1.7 mM, or treatment for this); reduced HDL-cholesterol (<1.03 mM in males and <1.29 mM in females, or treatment for this); will be classified as being at risk of metabolic syndrome. Post-test reclassification will determine changes to metabolic syndrome status after 6 months.

Blood samples will be taken by a phlebotomist at baseline and 6 months to measure a range of markers of cardiovascular disease risk and metabolic syndrome status. Fasting plasma glucose will be measured to assess insulin sensitivity. Fasting lipid levels will also be determined to assess lipid profile and CVD risk. The concentrations

Table 1 Summary of outcome variables

Outcome variable	*Measuring instrument*
Metabolic syndrome diagnosis/ status	IDF criteria [5]
Glucose, triglyceride, cholesterol (total, LDL, HDL, non-HDL)	Blood samples [27]
Blood pressure	OMRON automatic BP monitor
Anthropometric measurements (BMI, waist circumference, waist-to-hip ratio, body fat and muscle percentage)	Body composition scale, stadiometer, measuring tape [28,29],
Physical activity (programmed, incidental)	ActiGraph GT3X Accelerometer [30]
Sedentary and physical activity behaviours	IPAQ [13]
Diet (fat, fibre, fruit, vegetable consumption)	Fat & Fibre Barometer [31]
Economic analysis	EQ-5D-3 L [32]

of triglycerides, total cholesterol and HDL cholesterol will be measured allowing determination of total-, LDL-, HDL-, and non-HDL-cholesterol levels [27]. All blood tests will be performed by Western Diagnostic Pathology.

Anthropometric measurements will be undertaken by a certified anthropometrist at baseline and at 6-months post-test, following the International Society for the Advancement of Kinanthropometry guidelines. These include height and weight, body fat and muscle percentage, waist and hip circumference using a portable stadiometer, body composition scale, and tape measures, respectively [28,29]. *BMI* is promulgated as the most useful epidemiological measure of obesity along with *waist circumference*, while *waist-to-hip ratio* has been suggested as a better predictor of CVD mortality [33]. *Height* will be measured while the participant is barefoot to the nearest 0.1 cm with a portable stadiometer. *Weight* will be measured (wearing light clothing without shoes) using an electronic scale and recorded to the nearest 0.01 kg. *Waist and hip circumference* will be measured standing up at the level midway between the lowest rib margin and the iliac crest to the nearest 0.5 cm. *Hip* circumference will be measured at the largest level of the symphysis pubis and gluteus maximus. *Waist-to-hip ratio* will be calculated as waist circumference divided by hip circumference. *Blood pressure* will be measured by the trained research assistants using an Omron M5-1 electronic sphygmomanometer. A mean value will be recorded after three consecutive measurements (30).

A *self-reported questionnaire* will be completed by all participants at baseline (0-month) and post- test (6-months). This will include questions on demographics and lifestyle (smoking and alcohol drinking), the *International Physical Activity Questionnaire* (IPAQ) [13], and the *Fat & Fibre Barometer*, a valid and reliable instrument to assess dietary behavioural change [31]. The IPAQ Short Form has undergone reliability and validity testing in 12 countries. It has been used in many settings and was specifically designed for population-based physical activity studies.

Accelerometers (ActiGraph GTX3) will be used to objectively measure physical activity in the intervention group [30]. Participants will be asked to wear an accelerometer for 7 days at baseline and at post-test. It will be worn at the left hip throughout waking hours, removed only for showering and swimming. Data collection will be set at one-minute intervals over the day. This information will be downloaded by researchers using the ActiLife 6 software. Data will be summarised into daily average counts (counts/mins/day) and activity durations (mins/day) in specific intensity levels (inactive, light, moderate, and vigorous). A calculated weight bearing Metabolic Equivalent Task score will be determined and compared within and between groups. This will allow monitoring of incidental activity and assessment of the effect of the intervention on physical activity levels. To ensure compliance, participants will receive instructions on the device and also complete a daily log [34].

Economic analysis

Economic analysis of the cost-effectiveness of the intervention program will be conducted by a Health Economist. This will involve two distinct elements; firstly, a cost analysis of the physical activity and nutrition program which will provide estimates of the actual cost of the program and inferences into cost of future programs. The second aspect will include the undertaking of cost-effectiveness [35]. Quality of life will be measured using the validated EQ-5D-3 L questionnaire which is a standardised measure of health status developed by the EuroQol Group [32]. The self-complete EQ-5D-3 L questionnaire will be administered at baseline and post- test. This is a simple questionnaire which is cognitively undemanding, taking only a few minutes to complete. Sensitivity analysis will be undertaken to test the robustness of the results.

Process evaluation

Process evaluation will assess: fidelity (quality); dose delivered (completeness); dose received (exposure, satisfaction); reach (participation rate); recruitment; and context (aspects of the environment influencing implementation or outcomes) of the intervention [36]. This will be conducted on the intervention group via a brief questionnaire administered by mail and/or internet. It will ask participants to evaluate the resources (readability, usefulness of advice, suitability and relevance to age group) based on procedures previously used by the research team [37]. Process evaluation is essential to identify the appropriateness of the intervention and research procedure.

A subgroup of the intervention participants (n = 20) will be randomly selected to take part in exit interviews. The sample size used is comparable to a previous study [13]. While the literature has identified that sample size recommendations for non-probabilistic, purposive qualitative studies can range from five to 25 participants, saturation usually occurs within the first 12 interviews [38]. Both program completers (n = 10) and non-completers (n = 10) will be contacted by telephone to gain their perceptions of the program and resources. The non-completers will be asked the reasons for withdrawal. Each interview is estimated to take between 20 and 30 minutes. Permission will be sought for recording the interviews.

Statistical analysis

Comparisons between the changes in intervention and control groups will be performed using univariate and multivariable statistical methods. Outcome variables at baseline and post- intervention will be used to test the hypotheses in association with the covariates and confounding demographic and lifestyle variables. Continuous

and categorical outcomes will be analysed using generalised linear mixed regression models, accounting for the correlations between repeated measures and clustering of the observations. Intention-to-treat analysis will be conducted to assess sensitivity of the results to the expected attrition and withdrawal of participants from the RCT.

All qualitative data will be transcribed within two weeks of interviewing. At least 10% of all data will be randomly selected and reviewed. Data will be coded and common themes or categories created. The information obtained will be collated, presented thematically and supported by direct quotes from participants. Data management of full transcripts and other text will be facilitated by NVIVO [38]. Participants' permission will be obtained but they will not be identified in transcripts.

The economic analysis will involve both a cost analysis and cost-effectiveness analysis. This will be carried out from the perspective of the health services, including both Medicare and non- Medicare health costs, over a time horizon of 2 years. A cost analysis will provide information relating to set up, recruitment and program implementation of the RCT. While the analysis will provide specific cost details about running the RCT, the main interest will focus on the costs associated with future roll-out. Estimation will allow healthcare organisations to gauge the cost of conducting a similar program in the future.

The cost-effectiveness analysis of the trial intervention will involve the construction of a decision analytical model that captures data on both the cost and effectiveness of the intervention and non- intervention groups. The cost-effectiveness analysis will compare the difference in costs and effectiveness of the intervention and control groups, by calculating the incremental cost per Quality-Adjusted Life-Years gained by the intervention.

Sample size

The power calculations are based on a logistic mixed regression model with the outcome variable being the prevalence of physical activity participation. Assuming 80% complete data across the assessments due to attrition and non-respondents, a total of n = 625 subjects satisfying the selection criteria will be initially recruited. In the power analyses, effect sizes of interest are associated with the time (pre-post) and intervention group parameters. For the mixed regression analysis, a final sample size of n = 500 [125 per gender by intervention condition] will provide sufficient power (80%) to detect a medium effect size at 5% significance level for the group by time interaction term accounting for gender but without other covariate adjustment.

Discussion

Results of the APAN study are due in late 2015

It is imperative to target middle-aged (50–69 years old) adults to address the increasing prevalence of overweight/obesity and chronic disease in Australia's ageing population [2]. Identifying those at risk of metabolic syndrome, who are at high risk of type 2 diabetes mellitus and cardiovascular disease, can potentially lead to reduced prevalence and delayed onset of these diseases [8,39]. Providing home-based interventions for middle-aged adults still in the workforce allows for greater engagement of this group through flexibility. Flexibility provided by home-based interventions for middle-aged adults still engaged in the workforce should potentially lead to greater engagement of this hard to reach group.

Developing cost-effective strategies for identifying and managing individuals with overweight/obesity and metabolic syndrome via screening will have implications for primary care, by providing a window of opportunity for early intervention [40]. This community-based intervention will also enable large scale field testing in a rural setting, an area where little research has been conducted. Strategies evaluated as being successful and appropriate can be rolled out in other rural communities.

Cost-benefit analysis will be performed to determine the potential reduction in future chronic disease-related health costs, providing recommendations for policy and planning actions relating to the control of overweight/obesity, metabolic syndrome screening and intervention. The outcomes of the project will have potentially significant benefits to the Australian community through reduced chronic disease prevalence and improved quality of life. It will also likely have relevance to similar communities internationally.

Additional file

Additional file 1: Figure S1. Study design.

Abbreviations

RCT: Randomised controlled trial; BMI: Body mass index; HDL: High-density lipoprotein; APAN: Albany physical activity and nutrition; PALS: Perth active living seniors; PANS: Physical activity and nutrition for seniors; LDL: Low-density lipoprotein.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

KB coordinated the APAN program and drafted the manuscript. KB, JJ, AL, AJ, PH, APH, and AA designed the study, and revised the manuscript. All authors read and approved the final manuscript.

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Publication 2: Effects of a home-based intervention on diet and physical activity behaviours for rural adults with or at risk of metabolic syndrome: a randomised controlled trial.

This publication addresses Objective 2:

2. Assess at post-test the change in physical activity and dietary behaviours of intervention participants relative to the control group.

Citation:

Blackford, K., Jancey, J., Lee, A. H., James, A., Howat, P., & Waddell, T. (2016). Effects of a home-based intervention on diet and physical activity behaviours for rural adults with or at risk of metabolic syndrome: a randomised controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, *13*, 13. http://dx.doi.org/10.1186/s12966-016-0337-2.

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Effects of a home-based intervention on diet and physical activity behaviours for rural adults with or at risk of metabolic syndrome: a randomised controlled trial

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Abstract

Background: This study aimed to determine whether a home-based 6-month lifestyle intervention program complemented by motivational interviewing could improve diet and physical activity behaviours in 50–69 year olds with or at risk of metabolic syndrome, residing in a disadvantaged rural Western Australian community.

Methods: Participants from the City of Albany and surrounding towns ($n = 401$) were recruited into a 6 month randomised controlled trial. They were screened for metabolic syndrome and randomly allocated to intervention ($n = 201$) or control group ($n = 200$). Baseline and post-test data collection for both groups included a self-report questionnaire which incorporated the Fat and Fibre Barometer and the International Physical Activity Questionnaire Short Form. The intervention group received the program materials at baseline and the control group was waitlisted. Generalised estimating equation models assessed repeated outcome measures over time.

Results: A total of 151 (75.1 %) intervention and 159 (79.5 %) control group participants completed post-test and were included in the analysis. After controlling for confounders, the intervention group achieved a marginally significant increase in their metabolic equivalent (MET) minutes of moderate intensity physical activity per week ($p = 0.049$), and significantly improved fibre intake ($p < 0.001$), fat intake ($p = 0.003$), and vegetable serves per day ($p = 0.002$) from baseline to post-test relative to the control group.

Conclusion: A home-based, low-cost intervention with motivational support can effectively improve the physical activity and dietary behaviours of adults aged 50–69 years with or at risk of metabolic syndrome residing in a disadvantaged rural area.

Trial registration: Anzctr.org.au Identifier: ACTRN12614000512628

Keywords: IPAQ-SF, Strength exercise, Walking, Sitting, Fibre intake, Fruit and vegetable intake, Fat avoidance, Obesity, Metabolic syndrome, Disadvantage

Background

Metabolic syndrome is characterised by several metabolic abnormalities including raised triglyceride levels, reduced high density lipoprotein (HDL) cholesterol, hypertension, hyperglycaemia, and abdominal obesity [1]. Individuals with metabolic syndrome are at a significantly increased risk of developing chronic diseases such as type 2 diabetes and cardiovascular disease [1, 2]. Prevalence of metabolic syndrome varies between populations, with estimates of approximately 13-30 % of adults in developing countries and 35 % in developed countries such as Australia and the USA [3]. Data from the United Kingdom suggests that prevalence increases with age [3].

Several risk factors are responsible for the majority of metabolic syndrome cases and cardiovascular diseases in developed countries [4]. These include high cholesterol, overweight/obesity, physical inactivity, high blood

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pressure, and limited fruit and vegetable intake [4]. The risk factors contributing significantly to the burden of disease in Australia are poor diet (11 %) and overweight/obesity (9 %) [5]. In 2011–12, 92 % of Australian adults were not consuming enough serves of vegetables to meet the Australian Dietary Guidelines, and just 49 % achieved the recommended target for fruit consumption [5], while only 40 % met the recommendation of at least 150 min per week of moderate intensity physical activity [5].

The gap in health risk behaviours between the least and most disadvantaged groups of the Australian population is widening, particularly for fruit and vegetable intake [6]. People living in lower socioeconomic areas of Australia are more likely to be physically inactive, engage in sedentary behaviour, and have abnormal glucose metabolism compared to those living in higher socioeconomic areas [7]. Similar effects have been noted across seven comparable countries, with higher socioeconomic neighbourhoods associated with increased consumption of fruit and vegetables [8].

Residents of rural and remote Australia experience higher rates of morbidity and mortality and have less access to health services than those in metropolitan areas [5]. These populations are more likely than city populations to be overweight or obese (70 versus 60 %), insufficiently active (60 versus 54 %), have high blood cholesterol (37 versus 31 %) and comprise more people aged over 65 years (16 versus 13 %) [5]. This results in an increased prevalence of overweight/obesity, metabolic syndrome, and in turn chronic diseases [9]. Targeted screening and interventions in these populations at high risk of developing cardiovascular disease and type 2 diabetes may lead to early identification of metabolic syndrome, early management and delayed onset of these chronic diseases [10, 11].

Interventions to address metabolic syndrome and related chronic diseases in older adults should encourage reduced sitting time and increased physical activity [12] in combination with diet modifications. These include limiting saturated fat, sugar and salt, and increasing fibre, fruit and vegetable consumption [1, 13, 14]. The literature indicates that structured behavioural interventions focusing on counselling, education, and support strategies can also assist positive behaviour change in individuals at risk of chronic diseases [15].

A recent systematic review of self-help interventions for adults at risk of chronic diseases suggests that strategies comprising goal setting and self-monitoring in combination with tailored feedback, contact via email, and online social support, may be more effective for achieving behaviour change [16]. However, it is difficult to determine the effectiveness of self-help interventions in disadvantaged target groups due to insufficient data [16]. In particular, there is a gap in the knowledge of the impact of home-based lifestyle interventions in the disadvantaged rural/remote Australian setting targeting older adults with metabolic syndrome [17].

The Albany Physical Activity and Nutrition (APAN) Program aimed to improve dietary and physical activity behaviours of 50–69 year old adults at risk or with metabolic syndrome. The APAN program was implemented in the City of Albany and surrounding towns in The Great Southern region of Western Australia, which provided access to a large number of older adults aged 50–69 years (8496) [18]. The Socio-Economic Indexes for Areas scores Albany at 987.4, indicating relative disadvantage (<1000) [19]. This population is representative of other Australian rural/regional areas. In addition, the Great Southern region's health profile suggests a need for increased access to health programs and services for residents [20]. The present study aimed to determine whether the APAN program effectively improved the physical activity, diet, and sedentary behaviours of participants.

Methods

Study design

The protocol of this trial has been described previously [21]. APAN was a two-arm randomised controlled trial of a 6-month physical activity, diet, and healthy weight management intervention. Data were collected from the intervention and control groups at baseline and post-test. The trial was registered with the Australian and New Zealand Clinical Trials Registry (ACTRN12614000512628) and the study protocol was approved by the Curtin University Human Research Ethics Committee (approval number HR149_2013). All participants provided informed consent prior to entry into the study.

Participants

Potential participants were required to be 50–69 years of age and classified as either at risk of, or with metabolic syndrome using the International Diabetes Federation (IDF) criteria [22] to be eligible for the study. To be considered at risk, participants were required to have a large waist circumference as the minimum requirement (waist circumference ≥94 cm for men or ≥80 cm for women [Europids, Sub-Saharan Africans, Eastern Mediterranean, Middle East]; ≥90 cm for men or ≥80 cm for women [South Asians, Chinese, Japanese]), plus one of the following parameters: raised triglyceride concentration (≥1.7 mM, or treatment for this); reduced HDL-cholesterol concentration (<1.03 mM in males and <1.29 mM in females, or treatment for this); raised blood pressure (systolic ≥130 mmHg or diastolic ≥85 mmHg, or treatment of previously diagnosed hypertension); raised fasting plasma glucose concentration (≥5.6 mM). Participants were classified as having metabolic syndrome if they

had a large waist circumference plus two of the other criteria stated above [23].

The following exclusion criteria applied: on a weight loss diet or having weight fluctuations of >5 % within the previous 6 months; previous diagnosis of diabetes mellitus (other than gestational diabetes); of Aboriginal or Torres Strait Islander decent; receiving specific treatment to lower blood glucose; or involvement in another physical activity program.

Procedure

Participants aged 50–69 years were recruited from towns within a 50 km radius of Albany, Western Australia. Recruitment of participants occurred in three stages. Figure 1 outlines the study procedure, participant flow, and samples sizes.

Screening stage 1

Individuals ($n = 12{,}723$) from the selected region were initially screened via the Computer Assisted Telephone Interview system using the Australian Type 2 Diabetes Risk Assessment Tool (AUSDRISK), which assesses the risk of developing type 2 diabetes mellitus based on anthropometric, demographic, and lifestyle characteristics [24]. Females with a score of ≥ 9 and males with a score of ≥ 12 were eligible for the next stage of screening ($n = 1134$), with 7342 individuals excluded and 4247 individuals who opted out.

Screening stage 2

Eligible individuals ($n = 1134$) were invited to attend a clinic in a central location in Albany. A total of 526 participants attended the clinic and 608 opted out. Anthropometry including waist circumference was measured during the appointment to confirm central obesity (waist circumference ≥94 cm for men or ≥80 cm for women, being the minimum IDF requirement) before progressing to the next stage. Based on this eligibility criterion, 40 participants were excluded, and a further 16 opted out after progressing to screening stage 3.

Screening stage 3

The remaining eligibility criteria were assessed at a local pathology laboratory via fasting blood sample and blood pressure measurements. Participants also completed a self-reported questionnaire to measure physical activity and dietary behaviours.

Participants meeting the full eligibility criteria ($n = 401$) were randomly allocated to either the intervention group ($n = 201$) or control group ($n = 200$), while adjusting for gender and metabolic syndrome status. Intervention group participants were provided the APAN program materials and allocated to one of two motivational support staff. The control group participants were waitlisted to receive their program after post-test data collection (6 months).

Baseline and post-test data collection included a self-reported questionnaire to measure participant dietary and physical activity behaviours. Of the 201 intervention and 200 control group participants who completed the questionnaire at baseline, 151 (75.1 % response rate) and 159 (79.5 % response rate) respectively completed the post-test questionnaire and were available for analysis of the self-reported outcome measures.

Intervention

This home-based program was low cost and tailorable to suit varying fitness levels and lifestyles. Its strategies included self-monitoring and goal setting, supported by printed and online material, and participants received email and telephone support using motivational interviewing techniques. The program built upon previous dietary and physical activity programs targeting older adults in a metropolitan area [25, 26], and was adapted for a rural/remote target group.

Theoretical basis

The Self-Determination Theory was applied as the theoretical framework for this study, complemented by Motivational Interviewing [27]. The theory explores human motivation in terms of behaviours that are autonomous (originating from self) and behaviours that are controlled (persuasion or coercion) [28]. Self-Determination Theory is the only motivational theory that identifies autonomy as a basic need for all humans that should be supported in health promotion interventions [29]. Individuals are more likely to engage in certain behaviours if they are valued and intrinsically motivated [30]. Advice from health professionals should be offered in an autonomous manner to allow for individual decision-making [27].

Program materials

Intervention group participants were provided with the APAN program materials designed to assist with self-monitoring and goal setting to improve diet, physical activity, and healthy weight maintenance. Recommendations were based on Australia's Physical Activity and Sedentary Behaviour Guidelines [31] and the Australian Dietary Guidelines [32], as well as previous successful interventions targeting older adults [25, 26]. Materials included a booklet, exercise charts, resistance band, nutrition panel wallet card, and a website with progress tracker and interactive blog. A detailed overview of the program materials has been described previously [21].

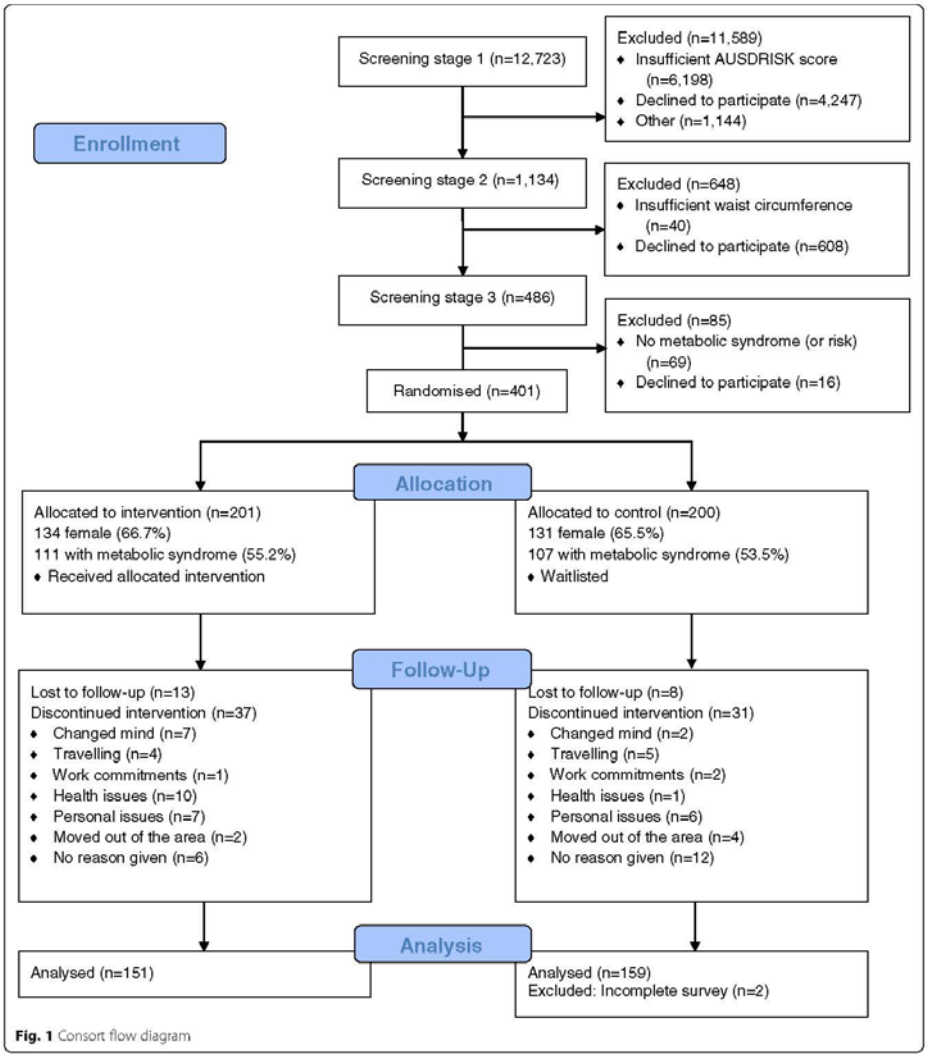

Fig. 1 Consort flow diagram

Motivational support

Intervention group participants were provided motivational support for the duration of the APAN intervention via telephone counselling and emails. Two research assistants trained in motivational interviewing techniques contacted participants at week 1, 3, 6, 12, 18, and 24. Motivational interviewing principles incorporate strategies to encourage an individual to initiate and sustain behaviour change, such as empathy, shared decision-making, and reflective listening [33]. These strategies complemented the principles of the Self-Determination Theory by ensuring participants set their own goals, became involved in decision-making, and were not coerced into a particular behaviour or action [27, 30].

Research assistants were provided with a dialogue guide for each of the six MI telephone calls scheduled over the intervention period. The first call focused on general health as the main topic, allowing the research assistants to introduce themselves to participants and gauge their readiness to change, barriers to change, and identify specific goals they wished to achieve. Subsequent calls focused on specific topics including physical activity, sedentary behaviour, nutrition, and the revisiting of goals. Participants were encouraged to utilise their APAN resources to monitor their progress and adjust goals and behaviours as required.

Instrument

The self-completed structured questionnaire included the Fat and Fibre Barometer [34], the International Physical Activity Questionnaire Short Form (IPAQ-SF) [35], and demographic and general health questions including sex, education, marital status, smoking status, diagnosed health conditions, medications, and alcohol consumption. The IPAQ-SF measured walking time, moderate and vigorous intensity physical activities, and time spent sitting across a usual week. A strength question was also added to determine resistance or weight training using large muscle groups [26].

To assess diet, the Fat and Fibre Barometer was utilised to provide information on habitual fat- and fibre-related behaviours of participants [34]. The valid and reliable instrument was appended with questions asking participants for the number of fruit and vegetable serves in a usual week [26]. Body mass index (BMI) was calculated based on weight and height data collected during screening stage 2.

Statistical analysis

This paper focuses on dietary and physical activity behaviours whereas changes in clinical metabolic syndrome parameters and anthropometry will be reported elsewhere. Descriptive statistics summarised the baseline lifestyle and demographic characteristics of the intervention and control groups. Independent and paired samples t-tests were applied to the continuous outcome variables, whereas Mann-Whitney U test and Wilcoxon Signed Rank test were applied to those variables exhibiting skewed distributions. To account for the effects of potential confounders, generalised estimating equation (GEE) models with exchangeable correlation structure were used to assess the repeated outcome variables over time. Normal GEE with identity link was applied to normally distributed continuous outcome variables (sitting time [hours per day]; fibre intake score; fat intake score; fat avoidance score), while gamma GEE with log link was applied to skewed continuous variables (walking time [MET min/week]; moderate intensity activity [MET min/week]; vigorous intensity activity [MET min/week]; total activity [MET min/week]; strength training [min/week]; fruit intake [serves per day]; vegetable intake [serves per day]). All statistical analyses were performed using the SPSS Statistics Package 22.

Results

Demographic and lifestyle characteristics of participants are summarised in Table 1, which highlight no significant differences between the intervention and control groups at baseline. The mean age of the sample was 61 years with 66.5 % female participants. The majority (98.4 %) had completed either secondary school or tertiary education, and 81.6 % had a partner. The mean BMI was 30.8 indicating that on average, the sample was obese. Smoking status and alcohol consumption were not significantly different between the two groups.

Physical activity outcomes

The self-reported physical activity outcomes between intervention and control groups are displayed in Table 2. Significant improvements in mean walking time (MET min/week), moderate intensity activity (MET min/week), total activity (MET min/week), sitting time (hours per day), and strength training (minutes per week) from baseline to post-test were observed for the intervention group, while a significant reduction (17 min/week) in total MET min/week was observed for the control group from baseline to post-test. Table 3 provides the results of the GEE analyses for physical activity outcomes. After controlling for potential confounders, the intervention group achieved a marginally significant improvement in the self-reported moderate intensity MET minutes per week ($p = 0.049$) relative to the control group. No significant improvement was observed for the other physical activity variables through the group x time interaction term.

Dietary outcomes

The dietary outcomes are compared between groups in Table 4. Significant improvements in all self-reported outcome measures from baseline to post-test were observed for the intervention group, whereas the control group demonstrated no significant changes. Significant differences were observed between groups at post-test for the fibre intake score ($p = 0.004$), fat intake score ($p < 0.001$), fruit intake ($p = 0.001$), and vegetable intake ($p < 0.001$). Table 5 provides the results of the GEE analyses for dietary outcome variables. After controlling for potential confounders, the intervention group demonstrated significant improvements in the self-reported fibre intake ($p < 0.001$), fat intake ($p = 0.003$), and serves of vegetables per day ($p = 0.002$) using the group x time interaction term.

Table 1 Baseline characteristics of intervention and control group participants

Variable	Intervention group ($n = 151$)	Control group ($n = 159$)	p value[a]
Age: mean (SD) years	60.5 (5.64)	61.3 (5.18)	0.181
Metabolic syndrome status:			0.494
With	79 (52.3 %)	90 (56.6 %)	
At risk	72 (47.7 %)	69 (43.4 %)	
BMI: mean (SD)	31.0 (5.88)	30.6 (5.17)	0.440
Gender: female	100 (66.2 %)	106 (66.7 %)	0.934
Employment status:			0.296
Full time	78 (51.7 %)	65 (40.9 %)	
Part time	24 (15.9 %)	29 (18.2 %)	
Unemployed	5 (3.3 %)	7 (4.4 %)	
Retired	44 (29.1 %)	58 (36.5 %)	
Education:			0.425
Primary school	3 (2.0 %)	2 (1.3 %)	
Secondary school	55 (36.4 %)	72 (45.0 %)	
Technical/Diploma	52 (34.4 %)	46 (28.8 %)	
University	41 (27.2 %)	39 (24.5 %)	
Relationship status: with partner	124 (82.1 %)	129 (81.1 %)	0.810
Smoking status:			0.852
Never	84 (55.6 %)	84 (52.8 %)	
Ex-smoker	52 (34.4 %)	54 (33.8 %)	
Occasional smoker	3 (2.0 %)	4 (2.5 %)	
Daily smoker	12 (7.9 %)	17 (10.6 %)	
Co-morbidity[b]: yes	92 (60.9 %)	104 (65.4 %)	0.413
Alcohol drinking: yes	99 (65.6 %)	113 (71.1 %)	0.957

[a] t-test or chi square test between intervention and control groups
[b] Presence of at least one of 8 common health problems

Discussion

Poor diet, physical inactivity, sedentary behaviour, and overweight/obesity are some of the major risk factors contributing to Australia's burden of disease [5]. These risk factors are more prevalent in disadvantaged and rural/remote communities in the older age groups [7], with the gap widening particularly for fruit and vegetable intake [6]. Consequently, interventions targeting this high risk group are essential to address the rising prevalence of obesity, metabolic syndrome, and chronic diseases in Australia [36, 37]. Assessment of changes to diet and physical activity behaviours of study participants provides an understanding of intervention compliance and the implication of changes in outcome measures [38].

This study examined the effectiveness of the APAN program for improving the dietary and physical activity behaviours of 50–69 year old adults at with, or at risk of metabolic syndrome in a disadvantaged rural area. The sample sizes provided sufficient statistical power to evaluate the repeated measures [21]. As expected, the attrition rate was higher for the intervention group (24.9 %) than the control group (20.5 %), and comparable to similar studies [39, 40].

The APAN program utilised the AUSDRISK [24] to initially screen individuals for risk of metabolic syndrome based on their risk of developing type 2 diabetes. To date no other studies report using this screening tool to identify metabolic syndrome in large populations. The screening process identified 1060 high risk individuals for developing type 2 diabetes, of which 215 (20 %) were confirmed to have metabolic syndrome and 186 (18 %) at risk of metabolic syndrome using the IDF criteria (central obesity plus one instead of two of the additional parameters). Targeted screening using AUSDRISK and the IDF metabolic syndrome criteria allows for evaluation of a timely lifestyle intervention to prevent the onset of cardiovascular disease and type 2 diabetes in rural Australian communities.

It is recommended that lifestyle interventions for disadvantaged groups incorporate self-help strategies due

Table 2 Comparison of self-reported physical activity outcomes between intervention and control groups

Outcome	Intervention group ($n = 151$)		p value[a]	Control group ($n = 159$)		p value[b]	p value[c]	p value[d]
	Baseline	Post		Baseline	Post			
	Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)			
Walking MET min/week[e]	396.0	577.5	0.011	330.0	396.0	0.047	0.561	0.050
	(561.0)	(742.5)		(594.0)	(709.0)			
Moderate MET min/week[e]	300.0	480.0	<0.001	360.0	360.0	0.808	0.394	0.189
	(585.0)	(850.0)		(640.0)	(636.0)			
Vigorous MET min/week[e]	181.5	217.5	0.070	203.0	179.5	0.715	0.902	0.176
	(479.4)	(460.2)		(462.1)	(428.4)			
Total MET min/week[e]	807.5	1332.0	<0.001	990.0	973.0	0.013	0.428	0.051
	(1486.9)	(1624.9)		(1357.5)	(1738.0)			
Strength min/week[e]	39.2	53.9	<0.001	27.7	25.0	0.436	0.880	0.001
	(168.9)	(124.2)		(66.8)	(70.4)			
Sitting hours/day	359.1	319.7	0.001	356.0	339.4	0.187	0.955	0.299
	(187.4)	(162.7)		(171.3)	(169.4)			

[a] Paired t-test (Wilcoxon signed-rank test) between baseline and post-test for the intervention group
[b] Paired t-test (Wilcoxon signed-rank test) between baseline and post-test for the control group
[c] Independent t-test (Mann-Whitney *U* test) between intervention and control group at baseline
[d] Independent *t*-test (Mann-Whitney U test) between intervention and control group at post-test
[e]Non-parametric tests applied

to the potentially high reach and low cost of implementation [16]. A systematic review of optimal methods and strategies for achieving lifestyle behaviour change in individuals with metabolic syndrome reported that interventions incorporating motivational feedback/interviewing in combination with internet monitoring and regular personal feedback are likely to achieve the best results [41]. Additionally, telephone-based services are able to reach geographically and socially disadvantaged areas, which commonly have higher risk of chronic diseases [42]. The APAN program incorporated a combination of these strategies to ensure the program was delivered in a cost-effective manner to the relatively disadvantaged participants in a rural community [19]. The observed changes to diet (fat, fibre and vegetable intake) and physical activity behaviours (moderate intensity activity) for the intervention group suggest that this combination of strategies is effective for the high-risk target group.

The APAN program was based on the Australian Dietary Guidelines [32]. Participants were encouraged to consume a diet high in fruit and vegetables with an emphasis on fibre intake, which is the recommendation for individuals with or at risk of metabolic syndrome [43]. The significant improvement in vegetable consumption and fat and fibre intake for the intervention group suggests that the APAN program demonstrates protective dietary factors to address metabolic syndrome in the target group.

The APAN program provided strategies for participants to identify and overcome barriers to improving physical activity and diet. Identified barriers to fruit and vegetable intake in the literature include a perception that enough serves of fruit and vegetables were consumed, as well as

Table 3 Regression analysis of physical activity outcomes before and after intervention ($n = 310$)

	Group: intervention		Time: post		Group x time	
	Coefficient (SE)	p[c]	Coefficient (SE)	p[c]	Coefficient (SE)	p[c]
Walking MET min/wk[a]	0.09 (0.16)	0.580	0.23 (0.10)	0.020	−0.10 (0.16)	0.524
Moderate MET min/wk[a]	−0.07 (0.16)	0.650	0.01 (0.11)	0.991	0.29 (0.15)	0.049
Vigorous MET min/wk[a]	−0.21 (0.19)	0.275	−0.14 (0.17)	0.393	0.15 (0.24)	0.537
Total MET min/wk[a]	−0.05 (0.13)	0.710	0.12 (0.08)	0.164	0.11 (0.12)	0.335
Strength min/wk[a]	0.01 (0.32)	0.983	−0.40 (0.22)	0.066	0.15 (0.34)	0.653
Sitting hours/day[b]	−10.61 (19.71)	0.590	−18.10 (12.54)	0.149	−20.86 (17.16)	0.224

[a]Gamma generalised estimating equation model with log link
[b]Normal generalised estimating equation model with identity link
[c]Adjusted for age, gender, relationship status, education level, employment status, co-morbidity, alcohol drinking, and smoking status

Table 4 Comparison of self-reported dietary outcomes between intervention and control groups

Outcome	Intervention group ($n = 151$)		p value[a]	Control group ($n = 159$)		p value[b]	p value[c]	p value[d]
	Baseline	Post		Baseline	Post			
	Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)			
Fibre intake score	23.3 (4.2)	24.9 (4.1)	<0.001	23.4 (4.0)	23.6 (3.8)	0.313	0.852	0.004
Fat avoidance score	12.8 (3.8)	13.3 (3.8)	0.016	12.8 (3.8)	12.8 (4.0)	0.743	0.933	0.234
Fat intake score	30.9 (4.0)	32.3 (4.0)	<0.001	30.4 (3.8)	30.8 (3.4)	0.082	0.194	<0.001
Fruit intake (serves/day)[e]	1.5 (1.3)	2.0 (1.4)	<0.001	1.5 (1.2)	1.4 (1.1)	0.378	0.619	0.001
Vegetable intake (serves/day)[e]	3.0 (2.3)	3.4 (1.9)	<0.001	2.5 (2.2)	3.0 (2.3)	0.570	0.277	<0.001

[a] Paired t-test (Wilcoxon signed-rank test) between baseline and post-test for the intervention group
[b] Paired t-test (Wilcoxon signed-rank test) between baseline and post-test for the control group
[c] Independent t-test (Mann-Whitney U test) between intervention and control group at baseline
[d] Independent t-test (Mann-Whitney U test) between intervention and control group at post-test
[e]Non-parametric tests applied

lack of variety, difficulty changing habits, lack of time to prepare, and low quality produce [44]. It has been suggested that interventions should provide practical solutions to address these barriers, and devise strategies to effectively communicate the recommended serves of fruit and vegetables to participants [44]. The APAN program supported participants by providing detailed information on food groups, recommended serves per day, sample meal plans, and tips for incorporating more fruit and vegetables into their daily meals, and the motivational interviewing component of the intervention encouraged participants to utilise these tools on a regular basis. Therefore, the significant increase in serves of vegetables per day for the intervention group is a successful achievement.

Based on Australia's Physical Activity and Sedentary Behaviour Guidelines [31], the APAN program recommended that participants aim for at least 150 min per week of moderate intensity physical activity in combination with a reduction in sitting time and strength training, as these activities all impact on metabolic syndrome outcomes. There was a marginal improvement in moderate intensity activity, which is encouraging as the risk of metabolic syndrome is almost doubled among adults who engage in no moderate intensity activity [43]. Although the intervention group demonstrated some improvement in sitting time, this change was not significantly different relative to the controls. Further research into strategies to encourage a reduction in sitting time in the home environment is recommended for the target group, including optimal motivational interviewing techniques to achieve this.

Loss of muscle mass and strength, or sarcopenia, affects wellbeing, physical movement, glycaemic control and blood pressure [45, 46]. Strength training is therefore a crucial component of any physical activity intervention targeting older adults due to its physiological effects [46]. The prevalence of strength training in Australian adults remains low, particularly in regional settings (21.9 % for men and 17.5 % for women) and adults aged 55+ (7 %) [46]. The intervention group did not achieve a significant increase in strength training time compared to the control group, highlighting the need for more effort to be placed on this. The APAN exercise chart was adapted from a previous study targeting older adults (60+ years) which might have been too simplistic and not challenging enough for the younger target group in the current study. Further adaptations should be considered for future interventions.

Limitations

A limitation of this study is the use of self-reported outcome measures which introduces reporting bias; however,

Table 5 Regression analysis of dietary outcomes before and after intervention ($n = 310$)

	Group: intervention		Time: post		Group x time	
	Coefficient (SE)	p[c]	Coefficient (SE)	p[c]	Coefficient (SE)	p[c]
Fibre intake score[b]	−0.06 (0.45)	0.897	0.20 (0.20)	0.329	1.39 (0.32)	<0.001
Fat intake score[b]	0.57 (0.43)	0.188	0.41 (0.23)	0.071	0.97 (0.33)	0.003
Fat avoidance score[b]	0.03 (0.42)	0.942	0.05 (0.18)	0.797	0.48 (0.28)	0.086
Fruit intake[a]	0.07 (0.07)	0.327	0.04 (0.04)	0.343	0.42 (0.26)	0.106
Vegetable intake[a]	0.07 (0.06)	0.292	0.04 (0.04)	0.321	0.17 (0.06)	0.002

[a]Gamma generalised estimating equation model with log link
[b]Normal generalised estimating equation model with identity link
[c]Adjusted for age, gender, relationship status, education level, employment status, co-morbidity, alcohol drinking, and smoking status

any inaccuracies in reporting are anticipated to be the same across intervention and control groups. Additionally, allocation concealment ensured that the participants were unaware of their group allocation which reduced the effect of any differential over-reporting of desired behaviours and under-reporting of undesired behaviours. Another limitation is the short duration of the intervention (6 months). It is commonly accepted that exposing older adults to a sufficient dose of an intervention to ensure behaviour change is maintained in the long term can be challenging [47]. Risk factors for metabolic syndrome are effectively controlled by intensive, short-term programs for weight loss; however once the programs end there are high rates of recidivism and individuals have a tendency to regain weight [41]. A follow-up study is therefore recommended to determine long-term effectiveness and sustainability of the APAN program.

Conclusions

Rural and remote communities are often neglected in lifestyle intervention research. It is therefore imperative that future interventions focus on sustainable health outcomes in real-world settings, particularly in disadvantaged groups. Considering the increased prevalence of preventable disease risk factors, it is essential to address poor diet, physical inactivity, and sedentary behaviour to reduce the prevalence of metabolic syndrome and related chronic diseases. The APAN program improved the physical activity and diet of the intervention group compared to the control group, demonstrating that a home-based, low-cost intervention with motivational support can effectively influence certain behaviour change of 50–69 year old adults with or at risk of metabolic syndrome in a disadvantaged rural area. The study findings thus contribute to the prevention and control of chronic diseases.

Abbreviations

APAN: albany physical activity and nutrition; AUSDRISK: Australian type 2 diabetes risk assessment tool; BMI: body mass index; GEE: generalised estimating equation; HDL: high density lipoprotein; IDF: International Diabetes Federation; IPAQ-SF: international physical activity questionnaire (short form); MET: metabolic equivalent of task.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

KB carried out recruitment and data collection, coordinated the intervention program, performed statistical analysis, and drafted the manuscript. KB, JJ, AL, PH & AJ participated in the design of the study, designed the program materials and measurement instruments. AL supervised statistical analysis. TW assisted with recruitment and data collection, and provided motivational support to study participants. All authors read and approved the final manuscript.

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Publication 3: Home-based lifestyle intervention for rural adults improves metabolic syndrome parameters and cardiovascular risk factors: A randomised controlled trial.

This publication addresses Objective 3:

3. Assess at post-test the change in body composition, MetS parameters, and cardiovascular risk factors for the intervention group relative to the control group.

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Home-based lifestyle intervention for rural adults improves metabolic syndrome parameters and cardiovascular risk factors: A randomised controlled trial

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ABSTRACT

The presence of metabolic syndrome (MetS) increases the risk of developing type 2 diabetes and cardiovascular disease. Targeted interventions to reduce MetS for high risk populations are crucial for the prevention of these chronic diseases. This study evaluated the effectiveness of a 6-month home-based physical activity and diet intervention for rural adults with, or at risk of MetS. The randomised controlled trial was conducted in Albany and surrounding towns, Western Australia, 2014–2015. Participants were screened for MetS using the International Diabetes Federation criteria, and eligible participants were randomly assigned to the intervention (n = 201) or control (n = 200) group. The intervention group received printed and online programme materials and motivational support, and the control group was waitlisted to receive the programme after post-test data collection. Anthropometry, lipid profiles, glycaemic status, and blood pressure were measured at baseline and 6-months post-test. In total, 312 (77.8%) participants completed post-test data collection and were included in the anthropometric analysis, and 274 (68.3%) participants were included in the blood sample analysis. After controlling for confounders, the intervention group significantly improved their triglyceride (−0.10 mM, p = 0.002), total cholesterol (−0.09 mM, p = 0.02), and non-HDL cholesterol (−0.08 mM, p = 0.02) concentrations compared to the control group. Waist circumference (−2.11 cm, p = 0.03), waist-to-hip ratio (−0.01, p = 0.04), weight (−0.70 kg, p = 0.01), and body mass index (−0.20 kg/m^2, p < 0.001) were also improved. These findings suggest that comprehensive home-based prevention programmes that include a combination of dietary and physical activity interventions are a promising means to prevent the onset of chronic disease in rural adults.
Trial registration:anzctr.org.au Identifier: ACTRN12614000512628

1. Introduction

Obesity and its associated chronic diseases are a growing public health concern worldwide. Since the 1980's, global overweight and obesity prevalence has increased by 28% in adults and 47% in children, which equates to an estimated 2.1 billion people (Ng et al., 2014). In Australia, approximately two-thirds (63%) of the population are overweight or obese (Australian Institute of Health and Welfare, 2014) which is an increase of approximately 9% in the last 17 years (Australian Bureau of Statistics, 2011). The proportion of adults aged 50+ who are overweight or obese has reached 70%, indicating that prevalence increases with age (Australian Bureau of Statistics, 2013a). Additionally, the prevalence of overweight/obesity has been rising more so among middle-aged adults living in harder to reach and often neglected rural/remote areas of Australia (Australian Bureau of Statistics, 2011).

The combination of excess weight and older age increases the prevalence of metabolic syndrome, which is defined by the presence of dyslipidaemia, hyperglycaemia, and hypertension (Blaha et al., 2008). Advancing age is a major contributor to all metabolic syndrome parameters (Grundy et al., 2004; Han & Lean, 2006). Prevalence also increases with body mass index (BMI) (Han &; Lean, 2006; Kassi et al., 2011), due to abdominal obesity being common to each of the metabolic syndrome parameters (Zimmet et al., 2005).

Metabolic syndrome is considered a worldwide epidemic (Alberti et al., 2009). It is estimated that approximately one fourth of adults worldwide carry the syndrome (Grundy, 2008). Individuals with metabolic syndrome are at increased risk of developing type 2 diabetes mellitus and cardiovascular disease (Blaha et al., 2008; Salas-Salvado et al.,

Abbreviations: APAN, Albany Physical Activity & Nutrition; ATPIII, National Cholesterol Education Program Adult Treatment Panel III; AUSDRISK, Australian Type 2 Diabetes Risk Assessment Tool; BMI, body mass index; GEE, generalised estimating equation; HDL, high density lipoprotein; IDF, International Diabetes Federation; LDL, low density lipoprotein; MET, metabolic equivalent; RCT, randomised controlled trial.

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2008). Of the one million Australians with diagnosed diabetes mellitus (Australian Institute of Health and Welfare, 2014), the majority of cases (85%) are type 2 which is a largely preventable disease (Australian Institute of Health and Welfare, 2014). Australian adults aged 65–74 years have the highest rate (15%) of diabetes compared to other age groups, and the 55–74 year age group has the highest rate of newly diagnosed cases (2.3%) of diabetes in Australia (Australian Bureau of Statistics, 2013b).

There is a high cardiovascular risk associated with individuals who have a metabolic syndrome diagnosis (Barazzoni et al., 2013), often due to the presence or increased risk of type 2 diabetes. For those with type 2 diabetes the risk of stroke is increased 2- to 4-fold, and the risk of myocardial infarction is increased 3- to 4-fold (Kaur, 2014). Diabetes ranks higher as a cause of death in rural and remote areas than major cities (Australian Institute of Health and Welfare, 2014), with the main contributor to higher mortality rates being coronary heart disease (Australian Institute of Health and Welfare, 2014). Other possible adverse health outcomes of metabolic syndrome include polycystic ovary syndrome, Cushing's syndrome, stress, depression, and some cancers (Han & Lean, 2006).

Management of chronic diseases and related health issues becomes difficult once they develop, highlighting the need for an early warning/screening system to protect those at risk (Sherwin & Jastreboff, 2012). The early identification of populations at risk of chronic disease provides an opportunity for the implementation of preventive measures (Australian Institute of Health and Welfare, 2014). In particular, identifying obese individuals at risk of, or with metabolic syndrome residing in rural/remote locations is a clinical priority (Barazzoni et al., 2013).

Implementing effective metabolic syndrome management is essential when considering its documented progression to type 2 diabetes, cardiovascular disease, and other health issues if left unmanaged (Camhi et al., 2010). A systematic review of 13 RCTs with 3907 individuals revealed lifestyle interventions to be more effective than pharmacological therapies at reversing metabolic syndrome (Dunkley et al., 2012), and in turn preventing its progression to cardiovascular disease and type 2 diabetes. It is now documented that all of the clinical markers of metabolic syndrome can be improved with diet and physical activity intervention (Bassi et al., 2014); therefore weight loss via diet and physical activity modification should be the focus of interventions (Mecca et al., 2012).

Effective lifestyle interventions directed at metabolic syndrome use a combination of counselling, motivational support, education, goal setting, and tailored feedback (Brauer et al., 2015; Hartmann-Boyce et al., 2015). A recent systematic review found that the optimal strategies to address metabolic syndrome were motivational support, internet monitoring, and regular personal feedback (Bassi et al., 2014), achieved via home-based self-help interventions. Such interventions may be particularly suitable for disadvantaged rural communities targeting older adults with or at risk of metabolic syndrome (Hartmann-Boyce et al., 2015; McNaughton et al., 2012).

Due to the ageing population and the higher proportion of older adults outside major cities (Australian Institute of Health and Welfare, 2014), rural areas will require more targeted services for older adults in the context of chronic disease prevention (Janus et al., 2007). Home-based interventions offer a solution to the barriers experience by rural populations such as limited access to health services and greater distances to travel to available services (Australian Institute of Health and Welfare, 2014), and are suitable for those who have employment commitments because the programme can be undertaken at any time. The effectiveness of home-based lifestyle interventions for older adults with metabolic syndrome residing in rural/remote Australian regions is under-researched (McNaughton et al., 2012). The Albany Physical Activity and Nutrition (APAN) programme aimed to address this gap by identifying and improving the lifestyle behaviours of rural adults with or at risk of metabolic syndrome. The purpose of the current study was to evaluate the effectiveness of the APAN intervention in terms of improvement in metabolic parameters and cardiovascular risk factors for this disadvantaged population subgroup. The changes in diet and physical activity behaviours have been reported separately (Blackford et al., 2016).

2. Methods

2.1. Study design and intervention

The APAN study was a RCT of a 6 month home-based physical activity and diet intervention, adapted from a 6 month intervention for a similar target group (Burke et al., 2012). The intervention strategies and resources included printed and interactive online programme materials, developed based on the Australian Dietary Guidelines (National Health and Medical Research Council, 2013) and Australia's Physical Activity and Sedentary Behaviour Guidelines (Department of Health, 2014). Participants were encouraged to set goals and self-monitor their progress, and received support from research staff using motivational interviewing techniques (Resnicow & McMaster, 2012). All participants were informed of the study aims and procedures, and provided written informed consent. Details of the study design and intervention have been described previously (Blackford et al., 2015). The study protocol was approved by the Curtin University Human Research Ethics Committee (approval number HR149_2013) and the trial was registered with the Australian and New Zealand Clinical Trials Registry (ACTRN12614000512628).

2.2. Participants

Adults residing in Albany and environs in the Great Southern region of Western Australia were contacted randomly via telephone. Interested participants were screened for study eligibility initially using the Australian Type 2 Diabetes Risk Assessment Tool (AUSDRISK) (Chen et al., 2010), followed by clinical measures obtained at a local clinic. Participants ($n = 401$), aged 50 to 69 years and classified as either having or being at risk of metabolic syndrome, were randomly assigned to a 6 month lifestyle intervention ($n = 201$) or control group ($n = 200$). The participants and recruitment procedure have been previously reported in detail (Blackford et al., 2016).

2.3. Definition of metabolic syndrome

Individuals at an increased cardiovascular risk can be identified using clinical definitions of metabolic syndrome (Blaha et al., 2008). The most current definitions are the National Cholesterol Education Program Adult Treatment Panel III (ATPIII) criteria and the International Diabetes Federation (IDF) criteria (Kassi et al., 2011). The IDF criteria address the causal link between central obesity and the other components of metabolic syndrome by ensuring obesity is an absolute in the screening process (International Diabetes Federation, 2006), and is therefore considered most suitable for clinical practice to prevent and manage obesity-related health issues (Kassi et al., 2011). The IDF definition has therefore been used to define metabolic syndrome in the present study.

The IDF definition (Han & Lean, 2006) includes a large waist circumference as the minimum requirement (waist circumference ≥ 94 cm for men or ≥ 80 cm for women [Europids, Sub-Saharan Africans, Eastern Mediterranean, Middle East]; ≥ 90 cm for men or ≥ 80 cm for women [South Asians, Chinese, Japanese]), plus any two of the following parameters: raised triglyceride level (≥ 1.7 mM, or treatment for this); reduced high density lipoprotein (HDL) cholesterol (<1.03 mM in males and <1.29 mM in females, or treatment for this); raised blood pressure (systolic ≥ 130 mm Hg or diastolic ≥ 85 mm Hg, or treatment of previously diagnosed hypertension); raised fasting plasma glucose (≥ 5.6 mM). The purpose of applying the IDF criteria in the present study was to ensure participants with central obesity were recruited to enable assessment of weight management and the associated clinical benefits of chronic disease prevention (Han & Lean, 2006).

Participants were classified as having metabolic syndrome if they met the full IDF criteria stated above. Participants who met the above requirement for central obesity and only satisfied one (instead of two) of the latter four additional conditions specified by IDF were classified as at risk of metabolic syndrome and also included in the present study. The aim of also targeting these individuals was to assess the effectiveness of the intervention at preventing the onset of metabolic syndrome and associated chronic diseases (Kaur, 2014; Hsiung et al., 2014). The full recruitment procedure has been reported previously (Blackford et al., 2016); however a summary is provided in Fig. 1.

2.4. Outcome measures

The primary outcome measures were changes to blood parameters, blood pressure, and anthropometry, measured at baseline and post-test. Fasting blood samples (>10 h) were taken by a phlebotomist at a local pathology lab. Fasting plasma glucose, cholesterol and triglyceride concentrations were measured, and low density lipoprotein (LDL)-, total-, HDL-, non-HDL-cholesterol levels were subsequently determined (Nordestgaard & Varbo, 2014). Remnant cholesterol was also determined due to the associated increased risk of cardiovascular disease (Nordestgaard & Varbo, 2014), as it is understood to be a more likely causal factor than reduced HDL cholesterol (Varbo et al., 2013). Systolic and diastolic blood pressure were measured by a trained researcher using an Omron M5-1 electronic sphygmomanometer. The participant was in a sitting position for 5 min prior to the first measurement. Readings were taken from the upper arm 1 min apart, with a mean value recorded after three measurements (Pickering et al., 2005). Waist and hip circumference were recorded to the nearest 0.5 cm using a plastic measuring tape, and waist-to-hip ratio (waist/hip) was subsequently

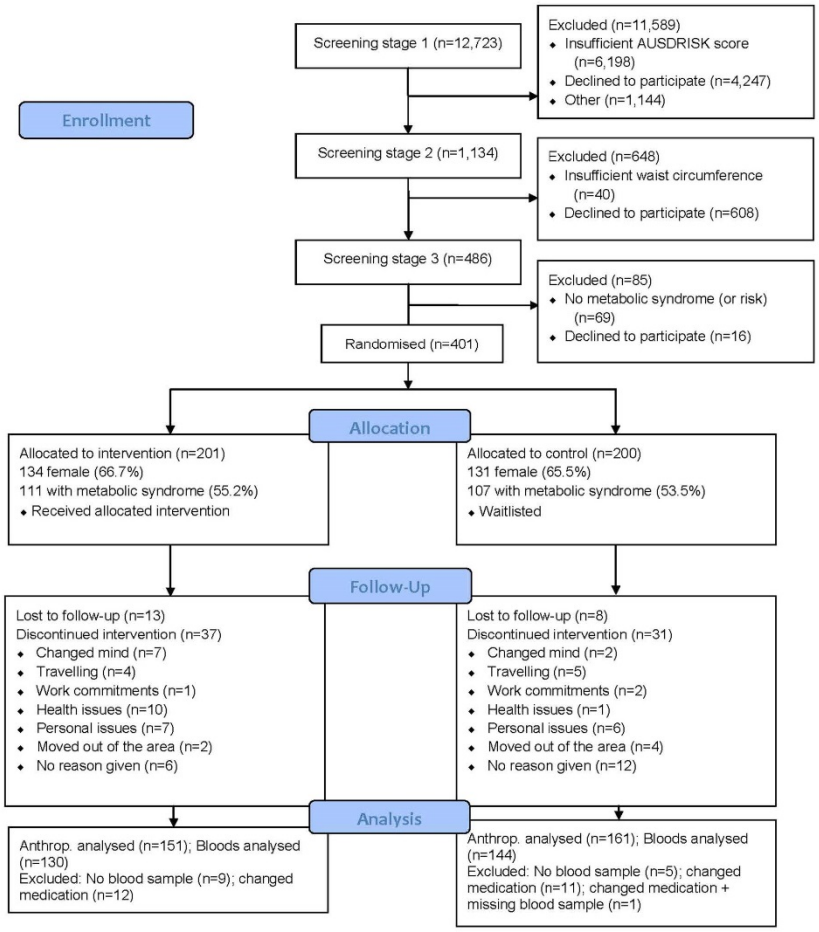

Fig. 1. CONSORT flow diagram Table 1 summarises baseline characteristics of the intervention and control groups. The sample consisted of predominantly females (66.5%) with an overall mean age of 61 years (SD = 5.41). There were no significant differences between the groups at baseline in terms of demographic characteristics, blood parameters, blood pressure, and anthropometric measurements. No differences were observed in comparisons of study completers and study dropouts.

determined (Welborn et al., 2003). Weight was recorded to the nearest 0.01 kg using a Tanita digital scale, and height was recorded to the nearest 0.1 cm using a stadiometer while the participant was barefoot. BMI (weight [kg] / height [m]^2) was subsequently determined.

2.5. Statistical analysis

Descriptive statistics summarised the baseline demographic and lifestyle characteristics, metabolic syndrome parameters, and anthropometric measurements of the sample. Continuous outcome variables were compared between and within groups using independent and paired t tests, with non-parametric Mann–Whitney U tests and Wilcoxon Signed Rank tests applied to variables with skewed distributions. Generalised estimating equation (GEE) models with exchangeable correlation structure were used to analyse repeated measures over time, while accounting for demographic and other potential confounders. Normally distributed continuous variables were assessed using a normal GEE model with identity link, whereas skewed continuous variables were assessed using a gamma GEE model with log link.

3. Results

Fig. 1 presents the CONSORT flow chart, which outlines the study procedure and sample sizes. The initial recruitment phase occurred from October 2013 to December 2014, with post-test measurements completed in August 2015. During the follow-up, 151 (75.1%) intervention and 161 (80.5%) control group participants returned to the clinic for post-test data collection and were available for anthropometric analysis, of which 151 (75.1%) intervention and 159 (79.5%) controls completed the questionnaire and were available for the analysis of demographic characteristics. At post-test, 21 intervention and 17 control participants did not attend the pathology lab for their blood samples or were excluded due to a change in medication from baseline to post-test, resulting in a final sample of 130 (64.7%) intervention and 144 (72.0%) control participants for blood analysis.

Table 1
Baseline characteristics of participants, Albany Western Australia, 2014–2015.

Variable	Intervention group	Control group	p value[a]
	(n = 151)	(n = 159)	
Age (years)	60.5 (5.64)	61.3 (5.18)	0.18
Gender: female	100 (66.2%)	106 (66.7%)	0.93
Employment status			0.30
Full time	78 (51.7%)	65 (40.9%)	
Part time	24 (15.9%)	29 (18.2%)	
Unemployed	5 (3.3%)	7 (4.4%)	
Retired	44 (29.1%)	58 (36.5%)	
Education			0.42
Primary school	3 (2.0%)	2 (1.3%)	
Secondary school	55 (36.4%)	72 (45.0%)	
TAFE/Diploma	52 (34.4%)	46 (28.8%)	
University	41 (27.2%)	39 (24.5%)	
Relationship status: with partner	124 (82.1%)	129 (81.1%)	0.81
Smoking status			0.85
Never	84 (55.6%)	84 (52.8%)	
Ex-smoker	52 (34.4%)	54 (33.8%)	
Occasional smoker	3 (2.0%)	4 (2.5%)	
Daily smoker	12 (7.9%)	17 (10.6%)	
Co-morbidity[b]: yes	92 (60.9%)	104 (65.4%)	0.41
Alcohol drinking: yes	99 (65.6%)	113 (71.1%)	0.96
	n = 130	n = 144	
Metabolic syndrome status			0.66
Metabolic syndrome	66 (50.8%)	77 (46.5%)	
At risk	64 (49.2%)	67 (46.5%)	

[a] t-Test or chi square test between intervention and control groups.
[b] Presence of at least one of 8 common health problems.

Table 2 gives the changes in cardiovascular risk factors within and between intervention and control groups. Significant improvements in triglycerides (−0.1 mM, p = 0.01), total cholesterol(−0.09 mM, p = 0.04), remnant cholesterol (−0.1 mM, p = 0.003), and both systolic (−5.24 mm Hg, p < 0.001) and diastolic blood pressures (−2.34 mm Hg, p = 0.002) were observed for the intervention group from baseline to post-intervention. There were no significant within-group changes in parameters for the control group. The GEE analyses for cardiovascular risk factors are provided in Table 3. After controlling for demographic and other potential confounders, significant improvements in the intervention group relative to the control group were observed for triglycerides (p = 0.002), total cholesterol (p = 0.02), non-HDL cholesterol (p = 0.02), and remnant cholesterol (p = 0.03) through the group x time interaction term.

Table 4 gives the univariate comparisons of anthropometrics between intervention and control groups. The intervention group significantly improved in waist circumference (−2.11 cm, p < 0.001), hip circumference (−1.25 cm, p < 0.001), waist-to-hip ratio (−0.01, p = 0.002), weight (−0.7 kg, p < 0.001), BMI (−0.2 kg/m^2, p < 0.001), and body fat (−1.5%, p < 0.001) from baseline to post-intervention. Table 5 provides the results from the GEE analyses of anthropometric outcome measures. Relative to the control group, the intervention group significantly improved in waist circumference (p = 0.03), waist-to-hip ratio (p = 0.04), weight (p = 0.01), and BMI (p < 0.001) through the group x time interaction, after controlling for potential confounders.

4. Discussion

There is a high prevalence of poor diet, physical inactivity, and overweight/obesity for older adults residing in rural areas of Australia (Williams et al., 2012). Consequently, the prevalence of metabolic syndrome, type 2 diabetes, and chronic disease is higher in these areas (Australian Institute of Health and Welfare, 2014), highlighting the need to develop interventions targeting this group (Janus et al., 2007). This RCT examined the effectiveness of the APAN programme for improving the metabolic syndrome parameters of participants, as a result of significantly improved dietary and physical activity outcomes (Blackford et al., 2016). The findings demonstrate that 6-months programme engagement in physical activity, nutrition, and weight management significantly improved several metabolic syndrome parameters and cardiovascular risk factors for the participants. Specifically, triglycerides, total-, non-HDL- and remnant-cholesterol were all improved for the intervention group when compared to the control group, and similar improvements were evident in anthropometric measurements such as waist circumference, waist-to-hip ratio, weight, and BMI.

Aerobic exercise and dietary modifications are considered to be effective interventions for metabolic syndrome, due to the associated improvements in blood pressure, waist circumference, triglycerides, and HDL cholesterol (Pattyn et al., 2013). Motivational interviewing combined with regular monitoring and feedback are recommended strategies for individuals with metabolic syndrome (Bassi et al., 2014), all of which had been implemented in the APAN programme. These strategies supported behaviour change, resulting in the intervention group moderately increasing metabolic equivalent (MET) minutes of moderate intensity physical activity per week, significantly increasing fibre intake and vegetable serves per day, and decreasing fat intake when compared to the control group (Blackford et al., 2016). These reported behaviour changes impacted on the individual metabolic syndrome parameters and cardiovascular risk factors.

It is recommended that weight reduction via dietary and physical activity improvements should be the primary intervention goal for individuals with metabolic syndrome due to the association between weight loss and lower cholesterol, triglycerides, glucose, and blood pressure, and increased HDL cholesterol (Blaha et al., 2008; Grundy et al., 2004). Specifically, a reduction in abdominal fat, measured by

Table 2
Comparison of changes in metabolic syndrome parameters and cardiovascular risk factors between intervention and control groups, Albany Western Australia, 2014–2015.

Outcome	Intervention group (n = 130)		p value[a]	Control group (n = 144)		p value[b]	p value[c]	p value[d]
	Baseline	Post		Baseline	Post			
Triglycerides (mM)e	1.48 (0.79)	1.36 (0.75)	0.01	1.37 (0.60)	1.47 (0.68)	0.02	0.19	0.09
Glucose (mM)	5.01 (0.46)	5.06 (0.53)	0.19	5.04 (0.49)	5.11 (0.56)	0.07	0.60	0.48
HDL cholesterol (mM)	1.46 (0.42)	1.45 (0.39)	0.44	1.46 (0.42)	1.44 (0.38)	0.45	0.88	0.89
Total cholesterol (mM)	5.56 (0.97)	5.47 (1.02)	0.04	5.40 (1.10)	5.45 (1.03)	0.29	0.19	0.87
LDL cholesterol (mM)	3.42 (0.81)	3.34 (0.95)	0.15	3.32 (0.93)	3.34 (0.90)	0.56	0.31	0.99
Non-HDL cholesterol (mM)	4.10 (0.89)	4.02 (0.96)	0.07	3.94 (1.01)	4.01 (9.33)	0.16	0.17	0.90
Remnant cholesterol (mM)e	0.60 (0.30)	0.50 (0.30)	0.003	0.60 (0.40)	0.60 (0.30)	0.06	0.43	0.05
Systolic blood pressure (mm Hg)	138.54 (14.05)	133.30 (14.85)	<0.001	138.56 (14.36)	136.32 (16.10)	0.07	0.99	0.09
Diastolic blood pressure (mm Hg)	87.21 (9.02)	84.87 (9.19)	0.002	85.99 (8.75)	84.96 (9.01)	0.15	0.26	0.95

[a] Paired t-test between baseline and post-test for the intervention group.
[b] Paired t-test between baseline and post-test for the control group.
[c] Independent t-test between intervention and control group at baseline.
[d] Independent t-test between intervention and control group at re-test.
[e] Non-parametric tests applied due to skewed distributions.

waist circumference, is associated with improved metabolic risk profile and reduced risk of cardiovascular disease (Lemieux et al., 2007). The significant reduction in waist circumference, waist-to-hip ratio, and blood lipids for the APAN intervention group suggests that the observed improvements in dietary intake in combination with increased physical activity (Blackford et al., 2016) not only assisted with improved body composition, but also led to improvements in individual metabolic syndrome parameters (Grundy et al., 2004). Abdominal fat mass is suggested to have a direct intermediary role in metabolic syndrome development (Han & Lean, 2006); therefore the observed reduction in waist circumference and other measures of body composition for the APAN intervention group may have directly influenced other metabolic syndrome parameters.

Individuals at the upper end of the normal BMI range are at a substantially increased risk of metabolic syndrome; therefore BMI maintenance at 21–22 kg/m^2 is recommended for those at risk of, or with metabolic syndrome (Han & Lean, 2006). A systematic review indicated that lifestyle interventions resulting in even modest weight loss can effectively improve blood lipids (Aucott et al., 2011). The intervention group of the APAN study demonstrated significant weight loss relative to the control group, as well as a significant reduction in BMI. The significant reduction in triglycerides, total- non-HDL- and remnant cholesterol for the APAN intervention group is therefore promising, considering the important role of blood-lipid regulation via dietary improvements, increased physical activity, and/or weight loss in prevention and treatment of metabolic syndrome and related chronic diseases (Aucott et al., 2011).

Even without weight loss, moderate intensity physical activity has been found to lower triglycerides (Ahmed et al., 2012). The mean moderate MET minutes per week reported by the APAN intervention group significantly increased from 300 (SD = 585.0) to 480 (SD = 850.0) minutes per week ($p < 0.001$) (Blackford et al., 2016), which suggests that improvements in triglycerides may have been observed regardless of weight loss. A systematic review reported significant changes in lipids when moderate intensity activities were performed for more than 150 minutes per week (Tambalis et al., 2009). The APAN intervention participants significantly reduced their triglycerides, which is consistent with a meta-analysis of RCTs that examined the effect of aerobic exercise on lipids (Kelley et al., 2005). The meta-analysis found that aerobic exercise effectively decreased triglycerides in overweight and obese adults (Kelley et al., 2005), which is consistent with other studies (Lin et al., 2015).

In addition to the beneficial effects on triglycerides, physical activity can also favourably influence other lipids. Non-HDL cholesterol includes all lipids apart from HDL cholesterol, and is considered a more reliable cardiovascular risk indicator than LDL cholesterol alone (Gordon et al., 2014). The APAN intervention group significantly reduced their non-HDL cholesterol concentrations relative to the control group, suggesting that the combination of increased physical activity and weight loss may have had a beneficial effect on cardiovascular risk. However, previous meta-analyses have found that non-HDL cholesterol could be significantly reduced as a result of aerobic exercise independent of weight loss (Gordon et al., 2014). Consequently, the reduction among the APAN participants may have occurred as a result of increased physical activity alone.

In addition to physical activity, many of the metabolic syndrome and cardiovascular risk factors are influenced by the Western diet, and can be reversed by improvements in dietary intake (Blaha et al., 2008). A

Table 3
GEE analysis of metabolic syndrome parameters and cardiovascular risk factors before and after intervention (n = 274), Albany Western Australia, 2014–2015.

	Group: intervention		Time: post		Grouptime	
	Coefficient (SE)	p*	Coefficient (SE)	p*	Coefficient (SE)	p*
Triglycerides (mM)[a]	0.08 (0.05)	0.14	0.07 (0.03)	0.02	−0.13 (0.04)	0.01
Glucose (mM)[b]	−0.04 (0.06)	0.54	0.06 (0.04)	0.08	−0.01 (0.05)	0.79
HDL chol (mM)[b]	0.04 (0.04)	0.33	−0.01 (0.02)	0.47	−0.00 (0.02)	0.93
Total chol (mM)[b]	0.21 (0.12)	0.07	0.06 (0.05)	0.26	−0.15 (0.07)	0.02
LDL chol (mM)[b]	0.12 (0.10)	0.24	0.02 (0.04)	0.55	−0.11 (0.07)	0.13
Non-HDL chol (mM)[b]	0.17 (0.11)	0.13	0.07 (0.05)	0.14	−0.15 (0.06)	0.02
Remnant chol (mM)[a]	0.10 (0.06)	0.10	0.06 (0.03)	0.03	−0.13 (0.06)	0.03
Systolic BP (mm Hg)[b]	−0.83 (1.65)	0.62	−2.19 (1.22)	0.07	−3.09 (1.64)	0.06
Diastolic BP (mm Hg)[b]	0.52 (1.02)	0.61	−0.99 (0.71)	0.17	−1.35 (1.01)	0.18

[a] Gamma generalised estimating equation model with log link.
[b] Normal generalised estimating equation model with identity link.
* Adjusted for age, gender, relationship status, education level, employment status, co-morbidity, alcohol drinking, and smoking status.

Table 4
Comparison of changes in anthropometric measurements between intervention and control groups, Albany Western Australia, 2014–2015.

Outcome	Intervention group (n = 151)		p value[a]	Control group (n = 161)		p value[b]	p value[c]	p value[d][d]
	Baseline	Post		Baseline	Post			
Waist circumference (cm)	102.67 (13.58)	100.56 (13.84)	<0.001	101.41 (12.93)	100.53 (12.69)	0.02	0.40	0.78
Hip (cm)	112.38 (11.99)	111.13 (12.04)	<0.001	111.57 (11.05)	110.57 (10.95)	0.02	0.54	0.67
Waist-to-hip ratio (waist/hip)	0.91 (0.08)	0.90 (0.08)	0.002	0.91 (0.08)	0.91 (0.08)	0.82	0.56	0.58
Weight (kg)[d]	85.20 (22.60)	84.50 (23.70)	<0.001	85.30 (21.90)	86.40 (22.00)	0.12	0.88	0.74
BMI (kg/m^2)[d]	29.55 (6.93)	29.35 (7.00)	<0.001	29.80 (7.05)	29.70 (6.90)	0.10	0.88	0.68
Body fat (%)[d]	40.20 (11.70)	38.70 (11.35)	<0.001	38.80 (12.75)	39.10 (12.80)	0.75	0.60	0.77

[a] Paired t-test between baseline and post-test for the intervention group.
[b] Paired t-test between baseline and post-test for the control group.
[c] Independent t-test between intervention and control group at baseline.
[d] Independent t-test between intervention and control group at re-test.
[d] Non-parametric tests applied.

diet rich in fruits, vegetables, and fibre is recommended for individuals with metabolic syndrome (Blaha et al., 2008). As such these recommendations were incorporated into the APAN programme strategies. Diets high in saturated fat are associated with oxidative stress and elevated LDL and total cholesterol, but not diets high in polyunsaturated fat (Esposito et al., 2004). Additionally, increased consumption of fruit, vegetables, and fibre appear to reduce inflammation (Kaur, 2014; Esposito et al., 2004). Implementation of the APAN programme effectively increased fibre and vegetable intake, and reduced the fat intake among the intervention group participants (Blackford et al., 2016), which might have reduced overall oxidative stress. It should be noted that total- and non-HDL cholesterol were significantly lowered for the intervention group.

The improvement of non-HDL cholesterol and triglycerides for the APAN intervention group suggests that improvements in dietary behaviours in combination with marginal improvements in moderate physical activity and weight loss may have reduced cardiovascular disease risk for participants. As a predictor of cardiovascular disease, non-HDL cholesterol is more relevant than LDL cholesterol, particularly in combination with elevated triglycerides (Blaha et al., 2008). The APAN intervention significantly reduced triglycerides and non-HDL cholesterol, suggesting that it is important to implement changes in both diet and physical activity to reduce cardiovascular risk.

4.1. Strengths and limitations

A major strength of the current study is the recruitment procedure implemented. There is a paucity of interventions that have used the IDF criteria to diagnose metabolic syndrome, which require central obesity to be a characteristic of participants (Higgins & Green, 2011; Lin et al., 2014). Our use of the IDF definition enabled the identification of individuals with a large waist circumference and ensured abdominal obesity and related risks were included as outcome measures (Lin et al., 2014), considering abdominal obesity and insulin resistance are the major underlying risk factors for metabolic syndrome and its components (Grundy et al., 2005). Previous reviews of metabolic syndrome trials have highlighted the need to utilise the current evidence and provide up-to-date guidance on the use of the IDF criteria to define and screen for metabolic syndrome (Dunkley et al., 2012; Lin et al., 2014). The IDF criteria is useful in large population groups because waist circumference as the minimum requirement provides a simple and low-cost screening process that can be performed at any location (Zimmet et al., 2005; Dhaliwal et al., 2014).

A limitation of the study was the brief duration of the intervention. There is a need to develop, evaluate, and disseminate strategies that effectively promote weight maintenance via lifestyle changes (Eakin et al., 2010). Although 6-month interventions are deemed to be long enough to reflect behaviour change (Stiggelbout et al., 2006), older adults often require a sufficient dose to ensure behaviour change is maintained, which can be challenging in the long-term (Burke et al., 2008). Short-term weight loss programmes are effective in the target group; but participants tend to regain weight once such programmes end (Bassi et al., 2014). Considering the relatively brief duration of the APAN intervention (6-months), it is recommended that longer-term studies are conducted to determine the sustainable effectiveness of similar lifestyle programmes (Korczak et al., 2011).

5. Conclusion

The APAN study has demonstrated the potential benefits of identifying and managing adults aged 50 to 69 years who have or are at risk of metabolic syndrome in a rural community. The home-based programme effectively improved dietary and physical activity behaviours of participants, which in turn improved individual metabolic syndrome parameters and cardiovascular risk factors. Comprehensive home-based prevention programmes that incorporate a combination of dietary and physical activity improvements are promising to prevent the onset of chronic disease in high risk population groups.

Table 5
GEE analysis of anthropometric outcomes before and after intervention (n = 312), Albany Western Australia, 2014–2015.

	Group: intervention		Time: post		Group x time	
	Coefficient (SE)	p[c]	Coefficient (SE)	p[c]	Coefficient (SE)	p[c]
Waist circumference (cm)[a]	1.16 (1.33)	0.38	−0.87 (0.38)	0.02	−1.17 (0.53)	0.03
Hip (cm)[a]	0.66 (1.26)	0.60	−0.98 (0.42)	0.02	−0.26 (0.50)	0.60
Waist-to-hip ratio (waist/hip)[a]	0.01 (0.01)	0.34	0.00 (0.00)	0.82	−0.01 (0.00)	0.04
Weight (kg)[b]	0.01 (0.02)	0.69	0.00 (0.00)	0.18	−0.01 (0.00)	0.01
BMI (kg/m)[b]	0.01 (0.02)	0.57	0.00 (0.00)	0.16	−0.01 (0.00)	<0.001

[a] Normal generalised estimating equation model with identity link.
[b] Gamma generalised estimating equation model with log link.
[c] Adjusted for age, gender, relationship status, education level, employment status, co-morbidity, alcohol drinking, and smoking status.

Conflict of interest

The authors declare no conflict of interest.

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Publication 4: Process evaluation of the Albany Physical Activity and Nutrition (APAN) program, a home-based intervention for metabolic syndrome and associated chronic disease risk in rural Australian adults.

This publication addresses Objectives 5 and 6:

5. Determine the effectiveness of strategies to recruit and retain the target group in a physical activity and dietary behaviour change intervention.

6. Assess the acceptability and appropriateness of the intervention strategies and resources for the target group.

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Process evaluation of the Albany Physical Activity and Nutrition (APAN) program, a home-based intervention for metabolic syndrome and associated chronic disease risk in rural Australian adults

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Abstract

Issue addressed: The Albany Physical Activity and Nutrition (APAN) study investigated the effects of the APAN program, a home-based intervention on dietary and physical activity behaviours and chronic disease risk for rural Australian adults. This paper reports on the process evaluation to gain insight into the link between intervention elements and outcomes.

Methods: The APAN program comprised resources to improve participants' diet and physical activity. Printed and online resources were provided to participants, complemented by motivational interviews via telephone. Process evaluation used mixed-methods, with a sample of 201 intervention participants residing in a disadvantaged rural area. Participants were aged 50 to 69 years with, or at risk of, metabolic syndrome. Quantitative data were collected using an online survey ($n = 73$); qualitative data were collected via telephone exit interviews with intervention completers ($n = 8$) and non-completers ($n = 8$), and recruitment notes recorded by research assistants.

Results: The attrition rate of the program was 18%; major reasons for withdrawal were health and personal issues and a loss of interest. The majority of participants found the printed resources useful, attractive, and suitable to their age group. The website was the least preferred resource. Reasons for completing the program included the desired health benefits, wanting to honour the commitment, and wanting to assist with research.

Conclusions: Carefully planned recruitment will reduce the burden on resources and improve uptake. Understanding reasons for attrition such as family or personal barriers and health issues will assist practitioners to support participants overcome these barriers. Given participants' preference for printed resources, and the known effectiveness of these in combination with other strategies, investigating methods to encourage use of telephone and online support should be a priority.

So what? This process evaluation provided an overview of recruitment challenges and preferred intervention components. It is desirable that future work determines the most effective intervention components for rural adults at risk of chronic disease.

Key words: behaviour change, chronic disease, obesity, program evaluation, rural and regional health.

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Introduction

Poor diet, physical inactivity, and obesity contribute significantly to the burden of disease in Australia,[1] due to the associated risk of metabolic syndrome, type 2 diabetes mellitus and cardiovascular disease.[2–4] In 2011–2012, only 8% of Australian adults met the Australian Dietary Guidelines for vegetable intake and 51% for fruit,

only 43% met the recommendation for moderate- or vigorous-intensity physical activity.[1] Adults living in rural and disadvantaged areas are more likely than their metropolitan counterparts to be physically inactive,[5] consume inadequate amounts of fruit and vegetables,[6] and be overweight or obese. Consequently, prevalence of metabolic syndrome, type 2 diabetes mellitus and cardiovascular disease is elevated in these regions,[1] highlighting rural populations as high-risk groups in need of intervention.

Combined diet and physical activity interventions are recommended for individuals at an increased risk of developing metabolic syndrome and associated chronic diseases.[7] Intervention strategies that incorporate multiple counselling and education sessions[8] plus goal-setting[9] have been shown to support behaviour change in these individuals.[7] Process evaluation of a study conducted in rural New South Wales found that obese individuals, who would probably benefit most from counselling, are more likely than the general population to engage with a telephone service.[10] It was recommended that future interventions targeting rural and disadvantaged adults should combine telephone counselling with online and printed resources,[11] and tailored feedback via email.[9]

The Albany Physical Activity and Nutrition (APAN) intervention aimed to encourage improvements in diet and physical activity for rural adults with, or at risk of, metabolic syndrome, to prevent the onset of associated chronic diseases. Participants were provided with printed and online resources, encouraged to set goals, and received tailored feedback via email and telephone. A randomised controlled trial (RCT) was conducted to evaluate the effectiveness of the APAN intervention in terms of dietary and physical activity improvements and their effects on weight management and metabolic syndrome parameters. The study protocol has been published previously, including an overview of the process evaluation plan.[12] The effects of the intervention on physical activity and dietary behaviours, also published elsewhere, included significant improvements in minutes of moderate intensity physical activity per week, fat and fibre intake scores, and serves of vegetables per day.[13]

Process evaluation is conducted to determine intervention effectiveness and to highlight reasons for success or failure.[14] Such reasons often include poor program design or implementation, and failure to reach the required target group numbers.[15] There is also a need to address the gap in understanding the effectiveness of diet and physical activity programs delivered online and via email,[16] and to determine reasons for attrition.[7] Understanding reasons for withdrawal and refusal to participate is imperative for interventions that target rural and disadvantaged target groups, due to the common issue of social exclusion and isolation.[17] The present study describes the process evaluation of the APAN intervention program to gain an insight into the link between intervention elements and outcomes, based on the process evaluation framework described below.[15]

Methods

Process evaluation design

Process evaluation of the APAN study was based on the framework described by Saunders *et al.*[15] The following components were assessed: a) the extent to which implementation of the intervention occurred as planned (fidelity – quality); b) the number of intended intervention components delivered (dose delivered – completeness); c) the extent to which participants used the resources as intended or recommended (dose received – exposure); d) participants' satisfaction with the program and staff (dose received – satisfaction); e) the number of participants actively participating in the intervention (reach – participation rate); f) procedures used to attract participants and maintain involvement in the intervention (recruitment); and g) factors that influenced the implementation or study outcomes (context).[15]

Setting and participants

This RCT of adults with, or at risk of, metabolic syndrome evaluated a physical activity and diet behaviour change intervention for the prevention of chronic disease. It was conducted in Albany, a rural area in Western Australia. The study protocol[12] was approved by the Curtin University Human Research Ethics Committee (approval number HR149_2013). All participants provided informed consent before their involvement in the study. Primary outcome results have been reported elsewhere.[13,18] A total of 401 participants were recruited. They were 50 to 69 years old with, or at risk of, metabolic syndrome based on the International Diabetes Federation criteria.[19] The intervention participants ($n = 201$) comprised the sample for the process evaluation.

Recruitment

Participants were recruited from towns within a 50 km radius of Albany in Western Australia. Screening and recruitment occurred in three stages, the procedure and participant characteristics have been published in detail previously.[13] Briefly, screening stage one was conducted via telephone using the Australian Type 2 Diabetes Risk Assessment Tool (AUSDRISK).[20] Screening stage two was conducted at a local clinic, where two trained researchers recorded anthropometric measurements. Screening stage 3 occurred at a local pathology laboratory for blood sample analysis to determine metabolic syndrome status. Participants who met the criteria for all three stages were eligible for the trial.

Intervention components

Self-determination theory (SDT) provided the theoretical basis for the intervention,[21] complemented by motivational interviewing.[22] In a health context, SDT is a general human motivation theory that focuses on participants' perception of the support for their autonomy.[23] The APAN intervention was based on several SDT constructs:[23] a) autonomy supportive climate – participants were encouraged to engage in health behaviours for their own reasons; b) autonomous orientation – participants' engagement in behaviours was based on personal values and interest; c) intrinsic

goals – participants were encouraged to set goals relating to personal growth; d) intrinsic motivation – motivation derived from inherent enjoyment of a particular behaviour.

The intervention consisted of several resources and strategies designed to improve the physical activity and dietary behaviours of participants, adapted from previous studies for a rural context.[24,25] Printed resources included an A4-sized educational booklet, exercise charts, and a nutrition panel wallet card to assist with reading food labels. A password-protected website was also available, which consisted of an interactive progress tracker and links to further physical activity and dietary information. All health information was based on the Australian Dietary Guidelines[26] and Australia's Physical Activity and Sedentary Behaviour Guidelines.[27]

The motivational interviewing component of the intervention consisted of regular telephone calls to the participants by two trained research assistants. Calls were scheduled for weeks 1, 3, 6, 12, 18, and 24 of the 6-month intervention. Interview schedules were based on the four constructs of SDT listed above, to promote autonomy and ensure behaviour change was intrinsically motivated. Additionally, the telephone calls were used to support goal setting and use of the program resources. A detailed overview of the resources and motivational interviewing component of the intervention has been described previously.[12,13]

Data collection

The process evaluation used a mixed-methods approach, with qualitative and quantitative data collected both during and after the intervention. Instruments comprised an online survey, exit interviews, and notes recorded by recruitment and research staff. The instruments aimed to answer the following key process evaluation questions:[15] a) who participated, who withdrew, and for what reasons? b) To what extent was the intervention delivered and received as intended? c) What were the participants' experiences and their suggestions for improvements? Table 1 provides an overview of the process evaluation questions and components and their corresponding measurement approaches.

Online survey

Evaluation of the APAN program resources was conducted at the 3-month point of the intervention via a self-administered online survey. Participants were sent a Survey Monkey (www.surveymonkey.com) link via email to evaluate the educational booklet, exercise chart, wallet card, and website. Questions were adapted from process evaluation instruments used in other studies[25,28] and included both open-ended questions and five-point Likert scales (e.g. very attractive to very unattractive; very suitable to very unsuitable).

Participants were asked to rate the extent to which they: a) found the resources useful; b) were attracted to the resources; c) found the resources suitable for their age; d) were encouraged by the resources to be more physically active; e) were encouraged to practice the program exercises; f) were encouraged to eat more fruit and vegetables; and g) were encouraged to eat less sugar, fat, and salt. Open-ended questions encouraged participants to comment on features they particularly liked or disliked about the resources and asked for suggestions for improvement. Participants were also asked to state whether they used specific components

Table 1. Process evaluation components and measurements

Component and definition	Measurement approaches undertaken		
	Online survey (3 months into intervention)	Exit interview (post-intervention)	Staff notes (during recruitment and intervention)
Who participated, who withdrew, and for what reasons?			
Recruitment Procedures used to attract participants and maintain involvement in the intervention			X
Reach (participation rate) The number of participants actively participating in the intervention	X	X	X
Context Factors that influenced the implementation or study outcomes	X	X	X
To what extent was the intervention delivered and received as intended?			
Fidelity (quality) The extent to which implementation of the intervention occurred as planned			X
Dose delivered (completeness) The number of intended intervention components delivered		X	X
Dose received (exposure) The extent to which participants used the resources as intended/ recommended	X	X	?
What were the participants' experiences and what were their suggestions for improvements?			
Dose received (satisfaction) Participants' satisfaction with the program and staff	X	X	

of the resources, such as the monthly activity planner in the booklet and the progress tracker on the website.

Exit interviews

Exit interviews were conducted via telephone with a purposefully selected sample of intervention completers ($n=8$) and non-completers ($n=8$). The sample size was based on a similar study,[28] with the literature suggesting that saturation occurs within the first 12 interviews.[29] A trained researcher who had no previous contact with participants followed a semistructured interview schedule, which included open-ended and closed questions to identify and evaluate: a) reasons for being involved in the program; b) the design features of the program that encouraged participation; c) the guidance and support provided by motivational interviewers; d) changes in physical activity and dietary attitudes and behaviours during the program; e) how the program might be improved.

Staff notes

During the recruitment stage staff recorded reasons provided by potential participants for not wanting to participate in the study. After the intervention commenced, they recorded why participants withdrew from the study.

Data analysis

Online survey data were downloaded directly from Survey Monkey into SPSS version 22. To facilitate analysis, variables recorded on the five-point Likert scales were collapsed into three levels to minimise respondent ambiguity in the positive and negative response categories.[30] For example, 'attractive' ('very attractive' combined with 'attractive') and 'unattractive' ('very unattractive' combined with 'unattractive'). Descriptive statistics were used to summarise the demographic characteristics of the sample and the survey results. Responses to open-ended questions and staff notes were transcribed verbatim into a text document and managed by NVivo 11.1. Qualitative data were coded and thematic analysis was performed to identify recurring patterns.

Results

Characteristics of respondents

One hundred and forty-five intervention participants were invited to participate in the online survey, 50.3% ($n=73$) completed the survey (64.4% female, mean age 61 years, s.d. ± 5.4). Twenty-eight intervention participants were randomly selected for the exit interviews, 57.1% ($n=8$ completers; $n=8$ non-completers) were successfully contacted and completed the interview (completers: 62.5% female, median age 61.5 years; non-completers: 62.5% male, median age 65 years).

Participants (recruitment, reach, and context)

The screening and recruitment stages occurred from October 2014 to December 2015. During screening stage one, 12 723 telephone numbers were called based on postcodes listed in the White Pages for Albany and environs. Of the people contacted via these telephone numbers, 57.6% ($n=7332$) agreed to participate in the AUSDRISK screening and 33.4% ($n=4247$) were not willing to participate. Some individuals opted to provide a reason for not wanting to participate. Table 2 provides a summary of the call statistics for screening stage one, including reasons for not completing the AUSDRISK questionnaire. The main reasons for non-participation as recorded by recruitment staff were: too busy ($n=71$); not interested in the program or research ($n=31$); perceived their health to be good ($n=26$); health issues ($n=21$); work commitments ($n=20$); personal issues ($n=19$); needle phobia ($n=18$); travelling ($n=16$); have their own exercise program ($n=11$); moving out of the area ($n=9$); dieting ($n=5$); and unwilling to change ($n=4$).

Of those who completed the AUSDRISK questionnaire, 15.5% ($n=1134$) were eligible for screening stage two, with the majority excluded for being outside the desired age group (57.9%, $n=3586$), not residing in the target area (13.3%, $n=824$), or having a lower AUSDRISK score than required (12.8%, $n=791$). Of the participants who were eligible for screening stage two, 46.4% ($n=526$) attended the clinic and 53.6% ($n=608$) opted out after receiving the invitation letter. After screening stage three, the final sample eligible for randomisation and included in the study was 401 (intervention ($n=201$); control ($n=200$)) participants.

After randomisation, all intervention group participants received the printed resources and those with computer access ($n=145$, 72.1%) also received the online resources. During the 6-month intervention period, 18.4% of participants ($n=37$) withdrew from the program and a further 6.5% ($n=13$) were lost to follow-up. Reasons for withdrawal were: health issues ($n=10$); personal issues ($n=7$); lost interest or changed their mind ($n=7$); not willing to provide reason ($n=6$); travelling ($n=4$); moved out of the area ($n=2$); and work commitments ($n=1$).

Intervention (fidelity, dose delivered, and dose received (exposure))

All participants were scheduled to receive six motivational telephone calls from research staff during the intervention. The purpose of the calls was to assist with goal setting and to motivate and encourage participants to use the program resources. Research staff recorded the number of phone call attempts and the number of successful calls over the intervention period. On average, participants completed three telephone contacts each,13.9% of

Table 2. Screening stage one: telephone call statistics ($n=12\,723$)

Result of call attempt	*n*	%
Yes (completed the AUSDRISK questionnaire)	7332	57.6
Not willing to participate	4247	33.4%
Business number	589	4.6%
Fax number	363	2.9%
Language barrier	45	0.4%
Hearing impaired	37	0.3%
Other	110	0.8%

participants ($n = 28$) refused to participate or were unable to be contacted, 53.7% of participants ($n = 108$) completed between one and three calls, and 32.3% of participants ($n = 65$) completed four or more calls.

Most online survey participants stated that the printed resources had encouraged them to be physically active (booklet 60.3%; exercise chart 61.1%), to eat more fruit and vegetables (booklet 68.5%), and to eat less sugar, fat, and salt (booklet 71.2%). Specific dietary changes, as noted by participants during the exit interviews, included smaller portions, reduced intake of sugar, alcohol, fat and processed food, and increased intake of fruit and vegetables, grains, and water. Specific changes to physical activity behaviours included increased stretching and balance exercises, particularly due to the exercise charts, increased gym use, and participation in sports.

The majority of participants did not use the monthly activity planner in the booklet (78.1%) or the progress tracker via the website (65.1%). Reasons given for not using the monthly activity planner in the booklet included: too busy ($n = 20$); already had a schedule or plan ($n = 8$); no motivation ($n = 8$); stopped after a while ($n = 7$); personal issues and distractions ($n = 6$); did not see the need ($n = 5$); forgot to use it ($n = 3$); and do not like to record things ($n = 3$). Reasons given for not using the progress tracker via the website included: did not use the website ($n = 9$); no time ($n = 9$); not confident with computers ($n = 7$); happy with current method ($n = 7$); stopped using it ($n = 6$); and no motivation ($n = 3$).

Participant satisfaction (dose received 9satisfaction))

The majority of participants found the printed resources useful (booklet 69.9%; exercise chart 69.4%), attractive (booklet 76.7%; exercise chart 73.6%), and suitable for people their age (booklet 78.1%; exercise chart 79.2%). The website was the least preferred resource.

During the online survey, participants were asked what they particularly liked about the program resources. The main reasons provided were aesthetics, ease of use, and awareness raising of the booklet. Suggestions for improvement included more dietary recommendations and recipes and a reduction in booklet size. The main reason participants liked the exercise chart was because it was easy to follow and had a magnet, making it easy to display on the refrigerator. Suggestions for improvement included having a range of more advanced exercises to try, and including a DVD to demonstrate these.

During the exit interviews, participants were asked to state reasons for being involved in the program. The main response themes were issues with weight, expected health benefits, and benefit to the community. Participants were also asked what motivated them to complete the program. Responses included desired health benefits, to honour the commitment, liking the challenge, and wanting to assist with research.

Participants were asked to comment on the guidance and support they received during the intervention. Reasons given for liking the support included the level of encouragement they received, suggestions for overcoming barriers, guidance to assist with the program resources, and the ability to contact research staff at any time for assistance. The main reason given for disliking the support was the lack of connection between the participant and caller.

Non-completers provided reasons for not continuing the program, which included being too busy, having personal or family issues, and lack of motivation. Suggestions to encourage sustained participation in the future were also provided. Responses included changing the delivery mode to face-to-face (individual or group) contact, having more regular feedback, and providing more incentives to complete the program.

Discussion

The process evaluation of the APAN program assessed the intervention in terms of participation, reach and participant satisfaction, and highlighted reasons for the program's success or failure. The outcomes suggest good participant adherence and acceptability of the program for the target group. Participants reported program resources to be attractive, useful and suitable for their age group, which encouraged them to improve their physical activity and dietary behaviours. These findings are supported by the significant improvements in moderate-intensity physical activity, and fat, fibre and vegetable intake for the intervention group.[13]

Recruitment of participants was time-consuming and resource-intensive. Screening stage one required cold calling, a method that relies on accessing publicly listed telephone numbers. Approximately one-third of the successful calls made were terminated due to unwillingness of the telephone contacts to participate. Furthermore, over half of the participants eligible for screening stage two opted out after receiving the study information sheet and letter requesting them to make an appointment at the local health clinic. It is possible that this request might place too great a burden on participants. The number of individuals opting out at this point could be reduced by the research staff making these arrangements.[31]

Although the recruitment method, which comprised several stages, was resource intensive, it reduced self-selection bias introduced through general advertising, thus increasing the likelihood of recruiting a more representative sample.[32] An alternative but less robust recruitment approach using AUSDRISK[20] to identify participants would be less resource-intensive and suitable for large populations.[13]

Identifying reasons for non-participation in studies that target disadvantaged groups will benefit future projects that aim to be more inclusive.[17] The attrition rate for the APAN intervention group

was 18%, which is similar to other studies targeting middle- to older-aged adults.[33,34] The process evaluation identified several reasons for participant withdrawal, with the majority citing health or personal issues or a loss of interest in the program, which are similar to those cited in similar studies.[28,32]

Reducing attrition ensures studies remain representative while minimising the risk of bias.[32] In order to reduce attrition in lifestyle interventions, a heavier focus on readiness-to-change assessment and understanding the benefits of behavioural change on chronic disease risk are warranted,[35] as well as providing tailored feedback and encouraging continued goal-setting.[34] APAN participants were encouraged to set goals and received tailored feedback, and were informed of the intervention aims and objectives. However, participants were not provided with their individual risk profile before commencing the intervention, which may help prevent withdrawal.[36]

Participation in the intervention was adequate, with 74.6% of participants finishing the 6-month program. Usage of individual program resources and support varied. The majority of participants used the education booklet and exercise chart, but most did not find the online component useful. This finding is consistent with a web-based physical activity and nutrition study targeting adults at risk of cardiovascular disease.[37] The APAN participants found the online tools to be time consuming and burdensome, which may suggest a design issue rather than an acceptability of mode issue. However, this is not unusual as other research indicates that it is common for participants to disengage with online programs over time.[37]

Web-based tools are recommended to complement traditional chronic disease intervention methods.[38] Therefore, strategies to make online components of interventions more effective and useful to participants should be investigated as suggested by the literature.[39] Addressing the determinants of engagement with online components using persuasive design (such as novelty, self-monitoring, aesthetics, reminders) as well as addressing determinants of behaviour change, is an important consideration for the design of websites.[40] A more valid measure of participant engagement with online components is also recommended, due to the limitation of self-reported use.

The majority of the intervention group participated in the motivational telephone calls, yet the prescribed number of telephone sessions was not completed by all participants. Nevertheless, they were given access to other communication channels such as printed resources and email support. These strategies have demonstrated effectiveness for rural adults when used in conjunction with telephone support.[10,11] Strategies to maintain participation in telephone support services should be further investigated, given the significant positive outcomes of previous diet and physical activity behaviour change interventions delivered via telephone.[41]

Strengths and limitations

A major strength of this process evaluation is the mixed-methods approach which incorporated a range of indicators to assess recruitment, dose, and satisfaction. Also, the combination of intervention strategies implemented was effective in changing the physical activity and dietary behaviours of the intervention group. Interventions that focus on goal setting, feedback, and self-monitoring appear to be more effective than programs that do not incorporate any of these strategies.[42] APAN was based on SDT[21] complemented by motivational interviewing.[22] This combination ensured participant autonomy, which seems to enhance motivation.

A limitation of this study is the lack of a face-to-face component. Face-to-face interventions are generally more effective than interventions using other communication methods;[42] however, it is important to note that the reach of an intervention and the cost of delivery is often better in distance-based interventions. Interventions tend to be more effective when there is an element of face-to-face contact in addition to an online component.[43] APAN participants mentioned this strategy as a potential improvement to the program. However, due to the remoteness of the rural study location, this would be challenging to implement. Perhaps video calling could be worthwhile but the older age of this group may limit its suitability.

Conclusions

The results of this process evaluation provide an overview of recruitment challenges, preferred intervention components, and possible improvements for interventions targeting older adults in rural areas. Carefully planned recruitment strategies have the potential to reduce the burden on resources and improve uptake and understanding reasons for attrition will assist practitioners to support intervention participants in overcoming barriers. Given the participants' preference for printed resources, and the known effectiveness of these in combination with other strategies, methods for successfully combining them with telephone and online support should be investigated. Being able to deliver a program without a face-to-face component makes the program potentially scalable in the rural context. However, methods to make the recruitment more streamlined should be investigated. Further work is required to determine the most effective intervention components for rural adults who are at risk of chronic disease.

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Appendix B: Copyright permissions

Blackford, K., Jancey, J., Lee, A. H., James, A., Howat, P., Hills, A. P., & Anderson, A. S. (2014). A randomised controlled trial of a physical activity and nutrition program targeting middle-aged adults at risk of metabolic syndrome in a disadvantaged rural community. *BMC Public Health, 15,* 284. http://dx.doi.org/10.1186/s12889-015-1613-9. [Impact Factor 2.26]

Blackford, K., Jancey, J., Lee, A. H., James, A., Howat, P., & Waddell, T. (2016). Effects of a home-based intervention on diet and physical activity behaviours for rural adults with or at risk of metabolic syndrome: a randomised controlled trial. *International Journal of Behavioral Nutrition and Physical Activity, 13,* 13. http://dx.doi.org/10.1186/s12966-016-0337-2. [Impact Factor 4.11]

Blackford, K., Jancey, J., Lee, A. H. James, A., Waddell, T., & Howat, P. (2016). Home-based lifestyle intervention for rural adults improves metabolic syndrome parameters and cardiovascular risk factors: A randomised controlled trial. *Preventive Medicine, 16*(89), 15-22. http://dx.doi.org/10.1016/j.ypmed.2016.05.012. [Impact Factor 2.893]

Blackford, K., Lee, A. H., James, A., Waddell, T., Hills, A. P., Anderson, A. S., Howat, P., & Jancey, J. (2016). Process evaluation of the Albany Physical Activity and Nutrition (APAN) program, a home-based intervention for metabolic syndrome and associated chronic disease risk in rural Australian adults. *Health Promotion Journal of Australia* (Online Early). http://dx.doi.org/10.1071/HE16027. [Impact Factor 1.231]

Appendix C: Statements of contribution

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6 September 2016

To Whom It May Concern

I, Associate Professor Jonine Jancey, contributed as a Supervisor of the PhD. I had ongoing and close involvement with the research, including contributing to the study and intervention design, read draft manuscripts, and suggested improvements for the following publications:

1. Blackford, K., Jancey, J., Lee, A. H., James, A., Howat, P., Hills, A. P., & Anderson, A. S. (2014). A randomised controlled trial of a physical activity and nutrition program targeting middle-aged adults at risk of metabolic syndrome in a disadvantaged rural community. *BMC Public Health*, *15*, 284. http://dx.doi.org/10.1186/s12889-015-1613-9. [Impact Factor 2.26]
2. Blackford, K., Jancey, J., Lee, A. H., James, A., Howat, P., & Waddell, T. (2016). Effects of a home-based intervention on diet and physical activity behaviours for rural adults with or at risk of metabolic syndrome: a randomised controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, *13,* 13. http://dx.doi.org/10.1186/s12966-016-0337-2. [Impact Factor 4.11]
3. Blackford, K., Jancey, J., Lee, A. H. James, A., Waddell, T., & Howat, P. (2016). Home-based lifestyle intervention for rural adults improves metabolic syndrome parameters and cardiovascular risk factors: A randomised controlled trial. *Preventive Medicine, 16*(89), 15-22. http://dx.doi.org/10.1016/j.ypmed.2016.05.012. [Impact Factor 2.893]
4. Blackford, K., Lee, A. H., James, A., Waddell, T., Hills, A. P., Anderson, A. S., Howat, P., & Jancey, J. (2016). Process evaluation of the Albany Physical Activity and Nutrition (APAN) program, a home-based intervention for metabolic syndrome and associated chronic disease risk in rural Australian adults. *Health Promotion Journal of Australia*. http://dx.doi.org/10.1071/HE16027 [Impact Factor 1.231]

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To Whom It May Concern

I, Professor Andy Lee, contributed as a Co-Supervisor of the PhD. I provided advice on statistical analysis, contributed to the study design, read draft manuscripts, and suggested improvements for all publications.

1. Blackford, K., Jancey, J., Lee, A. H., James, A., Howat, P., Hills, A. P., & Anderson, A. S. (2014). A randomised controlled trial of a physical activity and nutrition program targeting middle-aged adults at risk of metabolic syndrome in a disadvantaged rural community. *BMC Public Health*, *15*, 284. http://dx.doi.org/10.1186/s12889-015-1613-9. [Impact Factor 2.26]
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To Whom It May Concern

I, Doctor Anthony James, contributed as a Co-Supervisor of the PhD. I provided advice on collection and analysis of blood samples, contributed to the study design, read draft manuscripts, and suggested improvements for all publications.

1. Blackford, K., Jancey, J., Lee, A. H., James, A., Howat, P., Hills, A. P., & Anderson, A. S. (2014). A randomised controlled trial of a physical activity and nutrition program targeting middle-aged adults at risk of metabolic syndrome in a disadvantaged rural community. *BMC Public Health*, *15*, 284. http://dx.doi.org/10.1186/s12889-015-1613-9. [Impact Factor 2.26]
2. Blackford, K., Jancey, J., Lee, A. H., James, A., Howat, P., & Waddell, T. (2016). Effects of a home-based intervention on diet and physical activity behaviours for rural adults with or at risk of metabolic syndrome: a randomised controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, *13,* 13. http://dx.doi.org/10.1186/s12966-016-0337-2. [Impact Factor 4.11]
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To Whom It May Concern

I, Professor Peter Howat, contributed as a Co-Supervisor of the PhD. I provided ongoing support and involvement with the research, contributed to the study design, read draft manuscripts, and suggested improvements for all publications.

1. Blackford, K., Jancey, J., Lee, A. H., James, A., Howat, P., Hills, A. P., & Anderson, A. S. (2014). A randomised controlled trial of a physical activity and nutrition program targeting middle-aged adults at risk of metabolic syndrome in a disadvantaged rural community. *BMC Public Health*, *15*, 284. http://dx.doi.org/10.1186/s12889-015-1613-9. [Impact Factor 2.26]
2. Blackford, K., Jancey, J., Lee, A. H., James, A., Howat, P., & Waddell, T. (2016). Effects of a home-based intervention on diet and physical activity behaviours for rural adults with or at risk of metabolic syndrome: a randomised controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, *13,* 13. http://dx.doi.org/10.1186/s12966-016-0337-2. [Impact Factor 4.11]
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To Whom It May Concern

I, Professor Andrew Hills, contributed as a collaborator and contributed to the study design, read draft manuscripts, and suggested improvements for the following publications:

1. Blackford, K., Jancey, J., Lee, A. H., James, A., Howat, P., Hills, A. P., & Anderson, A. S. (2014). A randomised controlled trial of a physical activity and nutrition program targeting middle-aged adults at risk of metabolic syndrome in a disadvantaged rural community. *BMC Public Health*, *15*, 284. http://dx.doi.org/10.1186/s12889-015-1613-9. [Impact Factor 2.26]
4. Blackford, K., Lee, A. H., James, A., Waddell, T., Hills, A. P., Anderson, A. S., Howat, P., & Jancey, J. (2016). Process evaluation of the Albany Physical Activity and Nutrition (APAN) program, a home-based intervention for metabolic syndrome and associated chronic disease risk in rural Australian adults. *Health Promotion Journal of Australia*. http://dx.doi.org/10.1071/HE16027 [Impact Factor 1.231]

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To Whom It May Concern

I, Professor Annie Anderson, contributed as a collaborator and contributed to the study design, read draft manuscripts, and suggested improvements for the following publications:

1. Blackford, K., Jancey, J., Lee, A. H., James, A., Howat, P., Hills, A. P., & Anderson, A. S. (2014). A randomised controlled trial of a physical activity and nutrition program targeting middle-aged adults at risk of metabolic syndrome in a disadvantaged rural community. *BMC Public Health, 15*, 284. http://dx.doi.org/10.1186/s12889-015-1613-9. [Impact Factor 2.26]
4. Blackford, K., Lee, A. H., James, A., Waddell, T., Hills, A. P., Anderson, A. S., Howat, P., & Jancey, J. (2016). Process evaluation of the Albany Physical Activity and Nutrition (APAN) program, a home-based intervention for metabolic syndrome and associated chronic disease risk in rural Australian adults. *Health Promotion Journal of Australia*. http://dx.doi.org/10.1071/HE16027 [Impact Factor 1.231]

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11th August 2016

To Whom It May Concern

I, Tracy Waddell, provided assistance with recruitment and data collection, and provided motivational support to study participants. I read and approved draft manuscripts for the following publications:

2. Blackford, K., Jancey, J., Lee, A. H., James, A., Howat, P., & Waddell, T. (2016). Effects of a home-based intervention on diet and physical activity behaviours for rural adults with or at risk of metabolic syndrome: a randomised controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, *13*, 13. http://dx.doi.org/10.1186/s12966-016-0337-2. [Impact Factor 4.11]
3. Blackford, K., Jancey, J., Lee, A. H. James, A., Waddell, T., & Howat, P. (2016). Home-based lifestyle intervention for rural adults improves metabolic syndrome parameters and cardiovascular risk factors: A randomised controlled trial. *Preventive Medicine, 16*(89), 15-22. http://dx.doi.org/10.1016/j.ypmed.2016.05.012. [Impact Factor 2.893]
4. Blackford, K., Lee, A. H., James, A., Waddell, T., Hills, A. P., Anderson, A. S., Howat, P., & Jancey, J. (2016). Process evaluation of the Albany Physical Activity and Nutrition (APAN) program, a home-based intervention for metabolic syndrome and associated chronic disease risk in rural Australian adults. *Health Promotion Journal of Australia*. http://dx.doi.org/10.1071/HE16027 [Impact Factor 1.231]

Tracy Waddell (Co-author)

Krysten Blackford (Candidate)

Appendix D: Screening stage 1 instrument

MetS Project
Screening Questions

Interviewer Introduction
Good Morning/afternoon. My name is _____ I am calling on behalf of Curtin University.

Could I please speak to Mr/Mrs _____?

If the person is not available ask, "What would be an appropriate time to call back Mr /Mrs _____. Record suggested→Callback date/time.

If person is there, then <u>continue</u>

Good morning/afternoon Mr/Mrs_____
I'm calling on behalf of the Curtin University.

<u>Introduction</u>
We are would like to speak to people aged 50 to 69 about physical activity, nutrition, and health. We are not selling anything. The interview is very short and will only take about 5 minutes of your time. Is now a convenient time for you to answer the questions?

If **Yes 1→** Thanks and go to screening question 1.
If **No 2→**
↓

Could I call back at another time? **If yes**
What would be an appropriate time Record date/time
Thanks, I call you then
If No Thank you and close interview

No.	Date	Time	Interviewer Name	Disposition Code	Screening Complete	Call Back date	Call back time
1							
2							
3							
4							
5							
6							

Screening Questions

First I'd like to confirm if you are in the 50-69 age group.
(More than one person in age group - include both, if interested)

Yes	1	go to question 2
No	2	We are looking for people specifically in this age group - Thank you for your time.

1

Are you of Aboriginal or Torres Strait Islander descent?

Yes	1	Thank you for your time.
No	2	go to next question

I would like to ask you about your previous involvement in research programs.

Have you been involved in any research programs over the past 12 months that were to do with exercise or diet? *(completing surveys is ok – not actual participation in programs)*
(Researcher may need to follow – up if they are unsure)

Yes	1	Congratulations on your involvement in much needed research – Thank you for your time.
No	2	go to question 2

Weight reduction (exclude if weight hasn't been stable in last 6 months - weight fluctuations of >5% within the past 6 months)
Diabetic and/or treatment to lower blood glucose – exclude
Gastric banding (have/ or are planning to have) - exclude

AUSDRISK

Question	Answer option	Points
1. Your age group	50-54 years (4 points) 55-64 years (6 points) 65 years + (8 points)	
2. Your gender	Female (0 points) Male (3 points)	
3. Your ethnicity / country of birth	Australia (0 points) Asia, Middle East, North Africa, Southern Europe (2 points) Other (0 points)	
4. Have either of your parents, or any of your brothers or sisters been diagnosed with diabetes (type 1 or type 2)?	No (0 points) Yes (3 points)	
5. Have you ever been found to have high blood glucose (sugar) (for example, in a health examination, during an illness, during pregnancy)?	No (0 points) Yes (6 points)	
6. Are you currently taking medication for high blood pressure?	No (0 points) Yes (2 points)	
7. Do you currently smoke	No (0 points)	

cigarettes or any other tobacco products on a daily basis?	Yes (2 points)	
8. How often do you eat vegetables or fruit?	Every day (0 points) Not every day (1 point)	
9. On average, would you say you do at least 2.5 hours of physical activity per week (for example, 30 minutes a day on 5 or more days a week)?	Yes (0 points) No (2 points)	
10. Your waist measurement taken below the ribs (usually at the level of the navel, and while standing)	<u>Men</u> Less than 102 cm (0 points) 102 – 110 cm (4 points) More than 110 cm (7 points) <u>Women</u> Less than 88 cm (0 points) 88 – 100 cm (4 points) More than 100 cm (7 points)	
TOTAL		

<u>Total AUSDRISK score</u>
If 9 or higher, continue…

Thank you for answering those questions. Your answers indicate that you may be an ideal participant for our health research.

Curtin University will be conducting a **free** home-based physical activity and nutrition program in your town later in the year. The program will be conducted in two waves. All materials will be sent, and participation in activities is flexible, with no time outside of the home required. Blood samples will be collected at the beginning and end of the program to test whether the program has an effect on blood glucose and lipids.

Would you consider participating in this program?

A	No	☐	Thank you for your time	☐
B	Yes	☐	**Check address details** I will place a letter in the mail and your group leader will contact you in about a week or two. Would you be able to answer a couple more questions? Yes - go to question 4 No - Thank you for your time and good-bye	☐
C	Unsure	☐	Would like time to think about whether you wish to be involved in the program? I could send you some information on the program and phone you in a few days to check what you have decided.	Yes ☐ No ☐

Check Address details	☐

So I can send some information to you, can I please check your address?

Name_____
Address _____
Suburb_____ postcode
Phone number _____

4

Appendix E: Screening stage 2 instruments

Albany Physical Activity & Nutrition (APAN) Project

Participant Information Sheet

You have been invited to participate in this study because you are an Albany resident aged between 50 and 69 years. Please read this document carefully and feel free to ask any questions. Do not sign the informed consent form unless you fully understand the nature of the study and any possible side-effects. This will be given to you at your screening appointment.

Background information

As people age, the likelihood of suffering from chronic disease is increased. For many Australians an inadequate diet and/or low levels of physical activity can exacerbate these risks. Therefore, it is important to support the adoption of healthy lifestyle choices to help prevent or manage chronic diseases such as type 2 diabetes and cardiovascular disease.

What does the study involve?

The purpose of this study is to assess the effects of a lifestyle program on levels of physical activity and dietary intake. Your participation will involve a home-based program over a period of 6 months. The initial visit is a screening visit where we will assess your suitability to participate in the study. If suitable, you will be provided with program materials to complete at home in your own time.

Study plan

If you are eligible to take part in this study you will be asked to complete a series of lifestyle program modules designed for home use. Monthly telephone calls will be made by the project officer and/or research assistant to follow up on your progress. You will be required to attend an information collection appointment in a central location (Albany) at the beginning of the program and again at the end of the program. This will include completion of a brief questionnaire on physical activity and nutrition behaviours, body measurements, and the collection of blood samples. Details of the visits and requirements for the study are listed below.

Screening and data collection

The purpose of the screening visit is to determine your suitability to participate in the study, and to ensure that you completely understand all aspects of the research. For this visit you will be required to come to Amity Health, 106 Stirling Terrace Albany, in a fasted state i.e. consume your last meal 12 hours before your information collection appointment (e.g. 8pm the night before if you have an 8am appointment) and consume only water until after your appointment. During this visit we will obtain some blood from a vein in the arm using a needle. The blood samples will be sent to a laboratory and processed. The result of the processing is to measure fasting triglyceride (measure of fat), cholesterol, and glucose in your blood. The data will to be used to compile a combined health profile of all participants. These measurements will also be used as a comparison with post program measurements to assess the effect of the program on the group as a whole. Only the direct medical team have access to your name and records. All information leaving the clinic is not identifiable to you and your name will not be used in any reports or publications.

We will also measure your height, weight, waist and hip circumference, and blood pressure, and ask you a series of questions about your medical history, current diet and physical activity levels. Based on your answers to the questions and based on your fasting triglyceride, cholesterol, and glucose levels you will be told whether you are suitable to participate in the study. If you are suitable we will then explain in detail all aspects of the study.

The same measurements will be taken after the 6 month program has been completed.

Possible adverse effects

There is the possibility of discomfort with venepuncture (blood collection). It is important that you inform us if you experience discomfort. Your comfort during the procedures is of more concern than the collection of blood samples. In some people slight bruising and tenderness may appear afterwards at the site of blood collection. Bruising is usually minor and the arm will return to normal in a matter of days.

Ability to withdraw from study

It must be stressed that your participation in this study in entirely voluntary; you are free to withdraw from the study at any stage, whether that be before, during or after any blood collection or recording of information. It is important that you do not feel any pressure to complete the study particularly if it is not what you had originally anticipated.

Benefits to the participant

As a result of taking part in this study, you will gain useful information about your current lipid and cholesterol levels, percentage of body fat and anthropometric measurements (e.g. height, weight, body mass index (BMI, blood pressure)

Your participation in this study will provide us with important data enabling us to examine the role lifestyle programs play in chronic disease prevention. In Australia chronic diseases are the biggest cause of death and disability and it is hoped that results from studies such as this will enable us to determine ways to reduce these adverse incidences.

All information will be strictly confidential and any publication arising from this work will not include your name or any identifying feature.

If you have any queries or concerns you can contact the following staff at Curtin University:

- Krysten Blackford, Project Officer, on 9266 2751 or k.blackford@curtin.edu.au
- Professor Peter Howat, Project Supervisor, on 9266 1719 or p.howat@curtin.edu.au
- Dr Jonine Jancey, Project Supervisor, on 9266 3807 or j.jancey@curitn.edu.au
- Professor Andy Lee, Project Supervisor, on 9266 4180 or andy.lee@curtin.edu.au
- Dr Tony James, Project Supervisor, on 9266 2962 or t.p.james@curtin.edu.au

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This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number HR149/2013). The Committee is comprised of members of the public, academics, lawyers, doctors and pastoral carers. 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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DATE

«First_name» «Surname»

«Street»

«Suburb»

Dear «First_name»

Albany Physical Activity & Nutrition (APAN) Project.
Recently you were contacted by recruiters at Curtin University regarding the above project. Thank you for your interest in participating in this important research. Below you will find information regarding the screening data collection, dates, venues, and other important information.

Appointment 1
During your first screening visit we will collect the following measurements: height, weight, waist circumference, and blood pressure. We will also ask you to complete a brief questionnaire. You will need to be in a fasted state i.e. consume your last meal 12 hours before your appointment (e.g. 8.30pm the night before if you have an 8.30am appointment) and consume only water until after your appointment.

Please make a time with Amity Health, 106 Stirling Terrace Albany, ph (08) 9842 2797, as soon as possible. Appointments are available between **8.30am – 12pm ENTER DATES 2015.** If these dates/times are inconvenient please contact us as soon as possible.

Appointment 2
During your second screening visit we will be collecting blood samples. If you are eligible for this second visit we will provide information at the end of your first appointment.

Please note that there will be no cost to you for any part of the project, including these tests.

Important study details are enclosed for your information. Please read carefully and bring your consent form to your first appointment at Amity Health. You are welcome to ask questions prior to signing the form either in person, by phoning (08) 9266 2751, or emailing k.blackford@curtin.edu.au

We look forward to meeting you soon.

Kind regards

Krysten Blackford

APAN Project Officer

Participant ID:

Recorder ID:

Date: _____/_____/2015

Office use only: record participant id on participant record form

APAN
Albany Physical Activity & Nutrition

Dear Participant,

The Western Australian Centre for Health Promotion Research at Curtin University is conducting the Albany Physical Activity & Nutrition (APAN) research project.

This survey is part of the project and will allow us to assess the physical activity and nutrition behaviours of residents who live in Albany.

The Curtin University Human Research Ethics Committee has approved this project so that it meets ethical standards and ensures the confidentiality of participants' information is protected (Approval HR149/2013).

This survey should take less than 25 minutes to complete. If you change your mind and no longer want to take part in this study, you can withdraw from the survey at any time.

Things to remember

- **Read each question carefully.**
- **Tick one box for each question, unless the question asks for more than one answer.**
- **Ask the Research Assistants if you have questions or if there is anything you don't understand.**

PERSONAL DETAILS

Q.1 Are you:

Male…….. ☐ Female…….. ☐

Q.2 What is your age?

_____ years

For questions 3 to 5 please tick one box only.

Q.3 Which of the following best describes the highest level of education you have completed?

Primary school or lower…… ☐ High/secondary school …….. ☐

TAFE or trade certificate/Diploma … ☐ University/tertiary education ……. ☐

Q.4 Which of the following best describes your employment status?

Full time……..…… ☐ Part time/casual…….. …….. ☐

Retired …….. ☐ Unemployed…… ☐

Q.5 Are you?

Married/Defacto ..... ☐ Widow ..... ☐ Single ..... ☐

Q.6 Which of the following best describes your smoking status?

I smoke daily …….. ☐ I've never smoked …….. ☐

I smoke occasionally …… ☐ I'm an ex-smoker …….. ☐

Q.7 Do you have any of the following? (tick all that apply)

Heart disease …… ☐ Stroke …… ☐ High blood pressure ….. ☐

Diabetes …… ☐ Cancer …….. ☐ High cholesterol …… ☐

Osteoporosis ……. ☐ Arthritis ……. ☐ Other (please specify)_____

Q.8 Are you taking any of the following medications? (tick all that apply)

Blood pressure medication (e.g. Ramipril)…… ☐

Cholesterol medication (e.g. Lipitor) …… ☐

Blood clotting/Anti-platelet medication (e.g. Aspirin) …… ☐

Beta-blockers (e.g. Cartrol/Cartia) …… ☐

Arthritis (anti-inflammatory medication) …… ☐

Osteoporosis medication (e.g. Fosamax)…… ☐

PHYSICAL ACTIVITY

The following questions ask you about the time you spend on physical activity in a usual week.

Please answer each question even if you do not consider yourself to be an active person.

Q.9 Think about the time you spend walking in your usual week. This includes walking at home, walking you do at work, walking for travel from place to place, and any other walking that you might do in your spare time solely for recreation, sport, exercise, or leisure (for example, walking on a golf course; but do not include jogging)

a. During your usual week, on how many days did you walk for at least 10 minutes continuously?

_____ days per week

b. How much time did you usually spend walking on each of those days?

_____ minutes per day

Q.10 Think about all the moderate activities that you do in your usual week. Moderate activities refer to activities that cause a slight but noticeable increase in your breathing and heart rate, for example: mowing the lawn, digging in the garden, or medium-paced swimming or cycling, bicycling at a regular pace, or doubles tennis. **[Include only those physical activities that you did for at least 10 minutes continuously]**

a. Please list the moderate physical activities you do:

_____

_____

b. During your usual week, on how many days did you do moderate physical activities? [Please do not include walking]

_____ days per week

c. How much time did you usually spend doing moderate physical activities on each of those days?

_____ minutes per day

Q.11 Think about all the vigorous activities that you do in your usual week. Vigorous activities refer to activities that cause you to "huff and puff", where talking in full sentences between breaths is difficult, for example: squash, jogging, circuit training, brisk rowing, bicycling at a fast pace, actively participating in aerobics or fast swimming. **[Include only those physical activities that you did for at least 10 minutes continuously]**

a. Please list the vigorous physical activities you do:

_____

_____

b. During your usual week, on how many days did you do vigorous physical activities? [Please do not include walking.]

_____ days per week

c. How much time did you usually spend doing vigorous physical activities on each of those days?

_____ minutes per day

Q.12 Think about all the strength exercises that you do in your usual week. For example, activities such as resistance or weight training using large muscle groups.

a. List the strength activities that you do:

_____

_____

b. During your usual week, on how many days did you do strength activities?

_____ days per week

c. How much time did you usually spend doing strength activities on each of those days?

_____ minutes per day

Q.13 Think about the time you spent sitting during your usual week. Include time spent at work, at home, while doing study and during leisure time. This may include time spent driving,

sitting in a car, in a bus, train, sitting at a desk, using the internet, playing board games (e.g. bridge, mahjong), visiting friends, reading, or sitting or lying down to watch television.

a. Please list the sitting activities you do:

_____

_____

b. During your usual week, how much time did you spend sitting on a typical day?

_____ hours _____minutes per day

NUTRITION

Think about your consumption of fruit, vegetables, sugar, water and alcohol.

Please complete each question as accurately as possible.

Q.14a. In a typical week, on how many days do you eat fruit?

_____ days per week

b. How many serves of fruit do you normally eat on one of those days?

_____ serves per day

A standard serve of fruit is about 150g (350kJ) or:

- 1 medium apple, banana, orange or pear
- 2 small apricots, kiwi fruits or plums
- 1 cup diced or canned fruit (with no added sugar)
- Or only occasionally:
- 125ml (½ cup) fruit juice (with no added sugar)
- 30g dried fruit (for example, 4 dried apricot halves, 1½ tablespoons of sultanas)

6

Q.15a In a typical week, on how many days do you eat vegetables ?

_____ days per week

b. How many serves of vegetables do you normally eat on one of those days?

_____ serves per day

A standard serve of vegetables is about 75g (100-350kJ) or:

- ½ cup cooked green or orange vegetables (for example, broccoli,
- spinach, carrots or pumpkin)
- ½ cup cooked, dried or canned beans, peas or lentils
- 1 cup green leafy or raw salad vegetables
- ½ cup sweet corn
- ½ medium potato or other starchy vegetables (sweet potato,
- taro or cassava)

1 medium tomato

Q.16 On average, how many teaspoons of sugar do you usually take per day? [Include sugar taken with tea and coffee and on breakfast cereal].

_____ teaspoons per day

Q.17 How many standard alcoholic drinks do you have in a usual week? [For example, one standard drink is: 375ml can/bottle mid strength beer; middy ¾ can full strength beer, UDL can, bottle of alcopop, 100ml glass wine, full nip of spirits; or 60ml glass of port or sherry].

_____ standard drinks per week

Q.18 On an average day how many glasses of water do you drink?

_____ glasses per day

Q.19 Do you drink tea? [Including black tea, green tea or oolong tea/ herbal tea]

No ☐ Yes ☐

_____ cups per day **OR** _____ cups per week

Q.20 Do you drink coffee? [Including instant, filtered, decaffeinated]

No ☐ Yes ☐

_____ cups per day **OR** _____ cups per week

Now think about your consumption of fat and fibre.

Q.21 How many days a week do you eat two or more pieces of fruit?

Never …… ☐ 3-5 days a week..…….. ☐

Less than 1 day a week…..… ☐ 6 or more days a week..… ☐

1-2 days a week …… ☐

Q. 22 When eating cheese, how often do you choose reduced-fat cheeses in preference to regular cheese?

Never …… ☐ Rarely ……... ☐

Occasionally …… ☐ Usually …… ☐

Always …….. ☐ I don't eat cheese …….. ☐

Q.23 How many days a week do you eat fried food with batter or breadcrumb coating?

4 or more days a week …… ☐ 2 or 3 days a week …… ☐

Once a week …… ☐ Less than one day a week …. ☐

Never …….. ☐

Q.24 How often do you eat fried or roasted vegetables?

Always …… ☐ Usually …….. ☐

Occasionally …… ☐ Rarely …… ☐

Never …….. ☐

Q.25 When eating bread (as toast, sandwiches, or a snack), how often do you spread butter or margarine on it?

Always …… ☐ Usually …….. ☐

Occasionally …….. ☐ Rarely …….. ☐

Never …….. ☐

Q.26 How many serves of vegetables do you eat in a typical day?

None…… …… ☐ Less than 1 serve per day…. ☐

1 or 2 serves……..…. ☐ 3 or 4 serves……..…….. ☐

5 or more serves…… ☐

Q.27 How often do you trim all the visible fat off the meat you eat?

Never …… ☐ Rarely …….. ☐

Occasionally …… ☐ Usually …… ☐

Always …….. ☐ I don't eat meat …… ☐

Q.28 How often do you eat meat pies, pasties or sausage rolls?

3 or more times a week …… ☐ Once or twice a week ..…. ☐

Once a fortnight …… ☐ Less than once a fortnight.... ☐

Never …….. ☐

Q.29 How often do you (or the person who cooks for you) remove the skin from chicken before its cooked?

Never ……	☐	Rarely ……..	☐
Occasionally ……	☐	Usually ……	☐
Always ……..	☐	I don't eat chicken ……	☐

Q.30 How many days a week do you eat fried potato?

6 or more days a week ……..	☐	3 to 5 days a week……	☐
1 to 2 days a week……	☐	Less than one day a week….	☐
Never ……..	☐		

Q.31 How many days a week do you eat takeaway foods such as: fried or BBQ chicken; fish and chips; Chinese; Pizza or Hamburgers etc?

6 or more days a week ……..	☐	3 to 5 days a week……	☐
1 to 2 days a week……	☐	Less than one day a week….	☐
Never ……..	☐		

Q.32 How often do you (or the person who cooks for you) use fat when cooking?

Always ……	☐	Usually ……..	☐
Occasionally ……..	☐	Rarely ……..	☐
Never ……..	☐		

Q.33 How often do you choose wholemeal spaghetti or pasta in preference to regular spaghetti or pasta?

Never ……	☐	Rarely ……..	☐
Occasionally ……	☐	Usually ……	☐
Always ……..	☐		

Q.34 How often do you choose wholemeal or wholegrain bread in preference to white bread?

Never …… ☐ Rarely …….. ☐

Occasionally …… ☐ Usually …… ☐

Always …….. ☐

Q.35 How many days a week do you eat legumes (e.g. split peas, kidney beans, baked beans (navy beans), soybeans, chickpeas, four bean mix, Lupin, red, green or brown lentils) ?

Never …… ☐ Less than one day a week..... ☐

Once a week…… ☐ 2 or 3 days a week…….. ☐

4 or more days per week…… ☐

Q.36 How many days a week do you eat a high fibre breakfast cereal?

Never …… ☐ 3 or 5 days a week…….. ☐

Less than one day a week..... ☐ 6 or more days a week…… ☐

1-2 days a week…….. ☐

Q.37 How many different types of vegetables would you eat on a typical day?

None…… ☐ 1 or 2 types..…….. ☐

3 types…… ☐ 4 types……..…… ☐

5 or more types……..…… ☐

Q.38 How many days a week do you eat high-fat cheeses?

6 or more days a week …… ☐ 3 or 5 days a week…….. ☐

1-2 days a week ……..... ☐ Less than one day a week.... ☐

Never…… ☐

Q.39 How often do you choose low-fat milk in preference to full-cream milk?

Never ……	☐	Rarely ……..	☐
Occasionally ……	☐	Usually ……	☐
Always ……..	☐		

Q.40 How many days a week do you eat processed meats?

4 or more days a week……	☐	2-3 days a week..……..	☐
Once a week. ……	☐	Less than one day a week...	☐
Never.. ……..	☐		

Thank you for answering the questions. We really appreciate your time and assistance.

Please check through your questionnaire to make sure you have answered all of the questions.

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Web wachpr.curtin.edu.au

DATE

«First_name» «Surname»

«Street»

«Suburb»

Dear «First_name»

Albany Physical Activity & Nutrition (APAN) Program

We are pleased to confirm your eligibility for the APAN program.

Due to the size of the study, individual starting dates will be staggered over the coming months, and a package containing all program materials and information will be posted to you in due course. We ask that you please continue with your usual lifestyle until receiving your APAN package.

In the meantime, if you have any questions please call me on (08) 9266 2751 or email k.blackford@curtin.edu.au

Kind regards

Krysten Blackford

APAN Project Officer

Appendix F: Ethics

MEMORANDUM

Curtin University

To:	Professor Peter Howat
	Public Health - Centre for Behavioural Research in
CC:	
From	Professor Peter O'Leary, Chair HREC
Subject	Amendment approval
	Approval number: HR149/2013
Date	17-Mar-15

Office of Research and Development
Human Research Ethics Office

TELEPHONE 9266 2784
FACSIMILE 9266 3793
EMAIL hrec@curtin.edu.au

Thank you for submitting an amendment to the Human Research Ethics Office for the project:

HR149/2013 Evaluation of a home-based intervention targeting older adults with metabolic syndrome in a regional Australian community (Albany)

The Human Research Ethics Office approves the amendment to the project.

Amendment number: HR149/2013/AR1

Approval date: 17-Mar-15

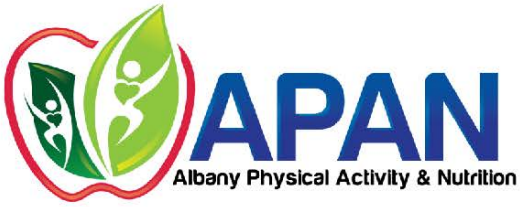
The following amendments were approved:

Extension of the data collection time points (collecting the same outcome variables) to 12 months (T3), 18 months (T4) and 24 months (T5) post program.
Participants will be provided with an updated information statement and consent

Please ensure that all data are stored in accordance with WAUSDA and Curtin University Policy.

Yours sincerely,

p.p. Professor Peter O'Leary
Chair, Human Research Ethics Committee



Albany Physical Activity and Nutrition Project

Consent Form

You have been invited to participate in this study because you are an Albany resident aged between 50 and 69 years old. Please read the information document carefully and ask any questions you wish. Do not sign this informed consent form unless you fully understand the nature of the study and any possible side effects.

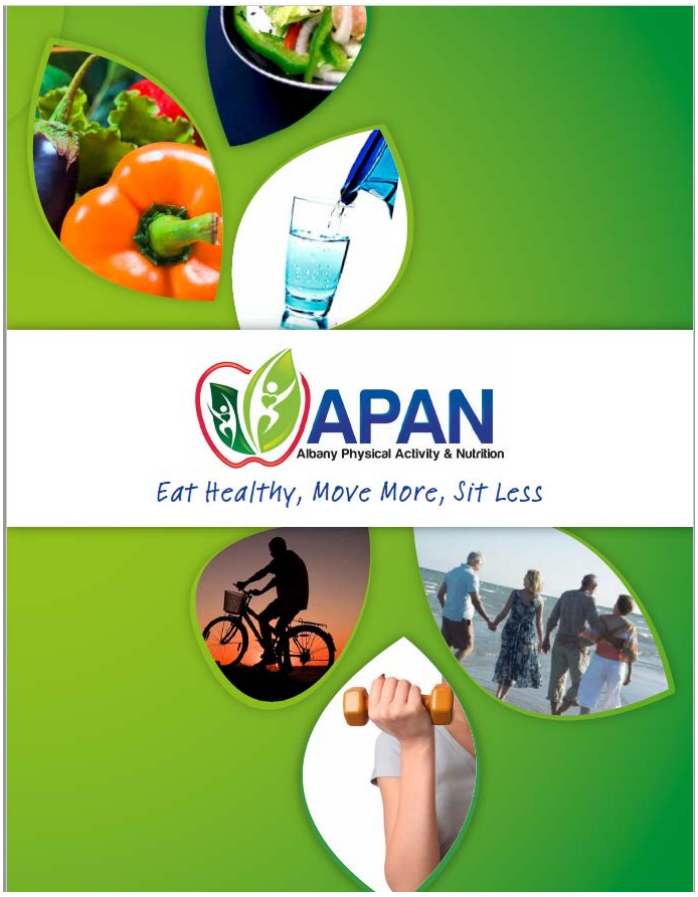
I,..... agree to participate in the above study. I have read and understood the Study Information and I have been given a copy of it. I understand the risks associated with participation in this study. I have been given the opportunity to ask questions about the study. I understand that I may withdraw from the study at any time.

Signed..... Date.....

Signature of Investigator..... Date.....

Appendix G: Intervention materials

Below is a selection of APAN Booklet sections:



Welcome to the Albany Physical Activity & Nutrition (APAN) program. This program aims to assist Albany residents to include physical activity and healthy eating into everyday living and maintain a healthy lifestyle. It is designed for insufficiently active 50-69 year olds and offers practical ideas to make healthy changes to nutrition and physical activity behaviour. The APAN program is full of ways to make healthy eating and physical activity simple and enjoyable.

The APAN program will help you to:

- Incorporate physical activity and healthy eating into everyday living
- Maintain a healthy lifestyle while going about your daily tasks
- Improve your mood, keep your energy levels stable, and prevent fatigue
- Reduce body fat
- Keep up with children and grandchildren and take part in family activities
- Protect against diseases such as diabetes and heart disease

Components of the APAN program include:

- Tips for maintaining a healthy weight
- Nutrition and physical activity recommendations and guidelines
- Goal setting to assist behaviour change
- Home-based exercise program including flexibility, strength, and balance exercises
- Healthy recipes, serving sizes, and meal plans
- Tracking your physical activity, nutrition, and healthy weight progress online via the APAN website
- Information about health issues
- Monthly activity planner
- Nutrition panel wallet card for healthy shopping
- Exercise program fridge magnets

Background

Many Australian adults are not sufficiently active and eat too much unhealthy food, leading to weight gain. Excess body weight, commonly referred to as overweight and obesity, is a major risk factor for several chronic diseases including diabetes, heart disease, and some cancers. The good news is that taking steps to lose the excess weight can reduce this risk, with many studies demonstrating that lifestyle programs greatly improve the health of participants.

People living in regional locations such as Albany do not always have the same access to health care that others do living in the city. The APAN program aims to address this gap by providing an easy-to-access home-based program for Albany residents.

APAN
Albany Physical Activity & Nutrition

The APAN program is a collaboration between the Western Australian Centre for Health Promotion (Curtin University) and South West WA Medicare Local.

medicare local SOUTH WEST WA

WESTERN AUSTRALIAN CENTRE FOR HEALTH PROMOTION RESEARCH

Curtin University

Published by
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School of Public Health
GPO Box U1987, Perth WA 6845 Australia

Principal Contributor and Project Coordinator
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Jonine Jancey, Peter Howat, Andy Lee, Tony James, Annie Holt, Linda Burke

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Acknowledgements: Alberta Centre for Active Living (Alberta, Canada), Australian Government: Department of Veterans Affairs & Department of Health, Australian Nutrition Foundation Inc, Department of Health (WA), National Health and Medical Research Council (NHMRC), Perth Active Living for Seniors project (PALS) Curtin University, Physical Activity and Nutrition for Seniors project (PANS) Curtin University, Retirement Village Physical Activity and Nutrition project (RVPANS) Curtin University, Professor Annie Anderson: University of Dundee, Professor Andrew Hills: The Univertisty of Queensland, World Health Organization. South West WA Medicare Local gratefully acknowledges the financial and other support from the Australian Government Department of Health.

Thank you to Justine Leavy and Sharleen Sowden who kindly offered to 'model' for the photographs and to those who contributed their time to editing the APAN booklet.

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Contents

Physical Activity

Being physically active offers many health benefits

- Reduce your risk of cardiovascular disease.
- Reduce your risk of type 2 diabetes.
- Maintain and/or improve your blood pressure, cholesterol and blood sugar levels.
- Reduce your risk of, and assist with rehabilitation from, some cancers.
- Prevent unhealthy weight gain and assist with weight loss.
- Build strong muscles and bones
- Create opportunities for socialising and meeting new people.
- Help you to prevent and manage mental health conditions.
- Help you develop and maintain overall physical and mental well-being.

Physical activity guidelines

Source: Australia's Physical Activity and Sedentary Behaviour Guidelines

Australia's Physical Activity and Sedentary Behaviour Guidelines have been developed so that people know the amount of physical activity they should do for health benefits.

Physical activity

- Doing any physical activity is better than doing none. If you currently do no physical activity, start by doing some, and gradually build up to the recommended amount.
- Be active on most, preferably all, days every week.
- Accumulate 150 to 300 minutes (2 ½ to 5 hours) of moderate intensity physical activity each week.
- Do muscle strengthening activities on at least 2 days each week.

Sedentary behaviour

- Minimise the amount of time spent in prolonged sitting.
- Break up long periods of sitting as often as possible.

Be active every day

Here are some ideas:

Travel:

- Walk or cycle for short trips.
- Take the stairs instead.
- Get off the bus one stop earlier and walk.
- Park further away and walk.

Work:

- Park your car an extra 5 or 10 minutes away.
- Walk to talk in person rather than emailing.
- Go for a walk at lunch time.
- Organise walking meetings.

Fun:

- Catch up with friends for a walk.
- Plan outdoor activities like bike riding.
- Try indoor activities if it's raining e.g. dancing, indoor swimming, squash.

Being physically active

Starting: Commence at a level comfortable to you and gently increase over time. Be sure to make gradual changes.

Dress for comfort: Wear clothes that allow you to move freely and suit the weather and wear comfortable shoes.

Support: Be active with a friend, or join a group.

Make it a habit: Mark down on your monthly activity planner (see back pages) the days and times you plan to be active, so you do not double book and miss out.

Duration: If you are not up to a 30-minute walk just yet, try to be active in smaller blocks. Start with 10–15 minutes and build from there in 5 minute blocks.

Intensity: Do not overdo it. Try the "Talk Test." For example, while walking briskly – make sure you are still able to have a conversation without puffing. However, try not to dawdle if chatting, and keep your walking pace fast enough to get your pulse (heart rate) up without making yourself breathless or uncomfortable. Increase speed slowly and gradually, for example – walk fast for 10 steps then resume normal speed and repeat. Add a gentle hill to your walk route before trying steep hills.

Refer to the exercise program on page 11 of this section for some easy to follow exercises

Home-Based Physical Activity Program

This stand-alone physical activity program is designed for you to do from home. It provides you with guidelines for endurance/ aerobic activity (e.g. walking), as well as a strength, balance and flexibility exercises.

The program will help you strengthen your muscles, improve your flexibility and balance as well as making you fitter and healthier.

No time? Try doing the strength, balance and flexibility exercises while watching your favourite TV show.

This program has been designed to help you become physically active on a regular basis as well as build up your strength, flexibility and balance.

Ultimately you want to include these types of exercises into your daily life. However, by starting out with one or two of them, you will be on the right track.

The key is to start being physically active at a level comfortable for you and gently increase the intensity over time.

If you struggle to complete the full program at the one time, try to be active in smaller blocks throughout the day. Choose activities you enjoy that involve continuous movement. Try and do a variety of activities.

If you feel any pain or discomfort, please discontinue the physical activity program and see your doctor.

Getting started

Before you commence you need to consider the following:

1. If you were advised to **consult your doctor** before participating in this program, please do so.
2. Always wear comfortable clothing suitable for physical activity. Make sure you have comfortable, supportive shoes and appropriate sun protection (when exercising outdoors).
3. Drink plenty of water. Make sure you drink water before, during and after exercise.

"I like to make a note of any exercise I do on my chart, so later I can check back to see how much I have done."

- John -

Warm up and cool down

At the start and end of your activity session make sure you warm-up and stretch to help increase muscle flexibility and reduce the possibility of any injury.

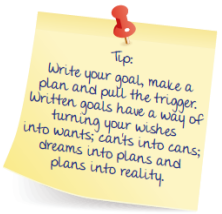
Warming up and cooling down

1. **Warm up**
   - Begin with 5 minutes of light intensity activity – walking on the spot, swing your arms low, then higher up, do some arm circles.
   - You may wish to work up to a slow jog on the spot.
   - Or go for a short walk in your neighbourhood.
2. **Stretches**
   - Do the stretches on the following pages at least once each, and hold for 15–20 seconds.
   - In the long-term aim for 3–4 repetitions.
3. **Cool down**
   - Repeat stretches at the end of your physical activity session and do 5 minutes of light intensity activity such as gentle walking

** Remember: start slowly and if you any feel any pain or discomfort, ease the stretch and do it again slowly. Only stretch to a comfortable point.*

"I like to write down what I eat or what exercises I do, to keep myself on the straight and narrow."

- Robyn -



Included in your package is an exercise chart to briefly remind you of the exercises in this program – keep your exercise chart somewhere handy to help to remind you of the range of exercises you can do.

Nutrition

The 5 food groups

Source: Australian Dietary Guidelines

1. Vegetables and legumes/beans
2. Fruit
3. Grain (cereal) foods
4. Lean meat and poultry, fish, eggs, tofu, nuts and seeds, and legumes/ beans
5. Milk, yoghurt, cheese and/or alternatives

Australian Guide to Healthy Eating

Enjoy a wide variety of nutritious foods from these five food groups every day.

Recommended serves for adults

Food group	Men 50–69	Women 50–69
Vegetables and legumes/beans	5 ½	5
Fruit	2	2
Grain (cereal) foods, mostly wholegrain and/or high cereal fibre varieties	6	4
Lean meat and poultry, fish, eggs, tofu, nuts and seeds, and legumes/ beans	2 ½	2
Milk, yoghurt, cheese and/or alternatives, mostly reduced fat	2 ½	4
Unsaturated spreads and oils	4	2

Vegetables and legumes/beans

What is a serve of vegetables?

One serve equals:

- 1 cup of salad
- 1 medium potato
- ½ a cup of cooked vegetables
- ½ a cup of cooked, dried or canned beans, peas or lentils

Eat plenty of vegetables every day (including legumes)

'Eating plenty' means eating at least five serves of vegetables each day. This is not as hard to achieve as you might think!

Ideas to get extra vegetable serves into your day

- Chop up some fresh vegetables to snack on during the day.
- Add some grated vegetables to your scrambled egg, omelette, or spaghetti bolognaise.
- Add one or two different vegetables to your stir fry – see how colourful and tasty you can make it.
- A home made vegetable soup with lentils, potatoes, carrots, pumpkin and celery gives you two to three vegetable servings for the day.
- Add left-over vegetables to an omelette or quiche to help increase the amount of vegetables you have in a day.

Fruit

What is a serve of fruit?

One serve is about 150g:

- 1 medium piece (apple, banana, orange or pear)
- 2 small pieces (apricots, plums or kiwi fruit)
- 1 cup diced pieces or canned fruit (no added sugar)
- ½ cup (125ml) 100% fruit juice
- 1½ tablespoons (30g) dried sultanas or 4 dried apricots

Include fruit in your day!
Try eating two serves of fruit every day (fresh, frozen, canned, or dried). Fruit juice contains vitamins but lacks fibre.

Ideas to get extra fruit serves into your day

- Chop up some fresh, dried or canned fruit and add to your cereal or as a dessert
- Freeze any over ripe bananas and use them to make a milkshake
- Stew or bake fruit
- Make a banana custard
- Snack on fruit for morning or afternoon tea
- If you have a juicer or blender make home-made fruit and vegetable juice – carrot, apple, celery and ½ cup water and a couple of ice blocks

Grain (cereal) foods

What is a serve of bread, cereal, rice, pasta, noodles?

One serve equals:

- 2 slices of bread
- 1 medium bread roll
- 1 cup cooked rice, pasta, noodles
- 1 cup porridge, ½ cup muesli
- 1⅓ cups of breakfast cereal flakes

Lean meat and poultry, fish, eggs, tofu, nuts and seeds, and legumes/beans

What is a serve of lean meat and poultry, fish, eggs, tofu, nuts and seeds, and legumes/beans?

- 65g cooked lean meats such as beef, lamb, veal, pork, goat or kangaroo (about 90–100g raw)*
- 80g cooked lean poultry such as chicken or turkey (100g raw)
- 100g cooked fish fillet (about 115g raw weight) or one small can of fish
- 2 large (120g) eggs
- 1 cup (150g) cooked or canned legumes/beans such as lentils, chick peas or split peas (preferably with no added salt)
- 170g tofu
- 30g nuts, seeds, peanut or almond butter or tahini or other nut or seed paste (no added salt)

**weekly limit of 455g*

Milk, yoghurt, cheese and/or alternatives

What is a serve of milk, yoghurt, cheese?

- 1 cup (250ml) fresh, UHT long life, reconstituted powdered milk or buttermilk
- ½ cup (120ml) evaporated milk
- 2 slices (40g) or 4 x 3 x 2cm cube (40g) of hard cheese, such as cheddar
- ½ cup (120g) ricotta cheese
- ¾ cup (200g) yoghurt
- 1 cup (250ml) soy, rice or other cereal drink with at least 100mg of added calcium per 100ml

Calcium: Include foods high in calcium – choose low fat varieties

Calcium is important for your bone health and can help protect against osteoporosis.

This is a condition where your bones become fragile and fracture easily. As you get older it is especially important to keep up your calcium intake.

Try to have three to four servings of low-fat milk or milk products every day, as these are excellent sources of calcium.

Unsaturated spreads and oils

Some fats provide essential unsaturated fatty acids and fat-soluble vitamins including vitamins A and E. Fats can be categorised as saturated fats, polyunsaturated fats and monounsaturated fats. Polyunsaturated fats can be further divided into omega-3 and omega-6 types.

Saturated fats: found in red meat, skin of poultry, lunch meats, butter, full fat milk, cream.

Polyunsaturated fats: omega-3 found in plant and seafood (salmon, tuna, mackerel, sardines); omega-6 found in nuts, seeds, and plant oils.

Monounsaturated fats: found in avocado, olive oil, canola oil, sunflower oil, nuts, and seeds.

Where possible, replace foods containing saturated fats with foods that have polyunsaturated and monounsaturated fats, which can benefit blood cholesterol levels.

Including small amounts of polyunsaturated and monounsaturated spreads and oils in cooking or in salad dressing or using a spread, or small amounts of nuts and seeds, can provide essential fatty acids and some fat-soluble vitamins.

What is a serve of unsaturated spreads and oils (250kJ)?

- 10g polyunsaturated spread
- 10g monounsaturated spread
- 7g monounsaturated or polyunsaturated oil, for example olive, canola or sunflower oil
- 10g tree nuts or peanuts or nut pastes/butters

What are legumes?

Legumes are beans (e.g. split peas, baked beans, lentils, blue peas; black-eyed, borlotti, broad, cannellini, lima, mung, pinto, kidney and soy beans). They are a good source of fibre and low in fat.

Physical activity required to burn one serve of discretionary choices:

- 40 minutes of brisk walking at a regular pace, or
- 30 minutes of dancing, or
- 30 minutes of bicycling at a moderate pace, or
- 40 minutes of gardening, or
- 45 minutes of housework, or
- 20 minutes of swimming, or
- 15 minutes of skipping.

Go for healthy sweet snacks instead:

- Fresh or frozen fruit
- Low fat yoghurt with fruit
- Wholemeal toast with mashed banana
- Home-made fruit muffins
- Oatmeal biscuits
- Dried fruit and nuts
- Slice of raisin/fruit bread or toast
- Low fat custard
- Wholemeal flour pikelets

Tips for healthy eating

Eating for health and well-being is about choosing foods from the Five Food Groups every day, while limiting foods that are not essential to our health.

- Keep a range of nutritious foods in your pantry from the five food groups so that you can eat at home more often.
- Eat a range of different types and colours of fresh vegetables and fruit.
- Add extra vegetables and legumes to your favourite recipes.
- Use fruit for sweet snacks and desserts.
- Lean red meats are important, but a maximum of 455g a week is recommended.
- Replace meat with eggs, legumes, nuts and seeds at least 1 or 2 meals each week.
- Choose reduced-fat milk, yoghurt and cheese.
- Choose unsaturated fats such as oils, spreads, nut butters/pastes and avocado in place of saturated fats.
- Drink plenty of water.
- When eating out, limit creamy, commercially baked or fried foods.

Alcohol

The Cancer Council recommends that to reduce the risk of cancer, alcohol consumption should be limited or avoided.

For people who do drink alcohol, the recommended amounts are:

- For men: Less than 2 standard drinks a day
- For women: no more than 1 standard drink a day

Healthy shopping

What you choose to put in your shopping trolley can affect your healthy eating goals. Below are some tips to ensure you stay on track:

- Make a list
- Avoid shopping on an empty stomach
- Read the label

Standard Drink

One standard drink is:

- 375ml can or bottle of mid-strength beer
- 1 middy or ¾ can of full-strength beer
- 1 UDL can or bottle of alcopop
- 100ml glass of wine or 60ml glass of port or sherry
- Full nip of spirits

Tip: Take your APAN wallet card shopping with you to assist with reading the Nutrition labels

Nutrition Information

Servings per package – 16
Serving size – 30g (1/3 cup)

	Per serve	Per 100g
Energy	432kJ	1441kJ
Protein	2.8g	9.3g
Fat		
Total	0.4g	1.2g
Saturated	0.1g	0.3g
Carbohydrate		
Total	18.9g	62.9g
Sugars	3.5g	11.6g
Fibre	6.4g	21.2g
Sodium	65mg	215mg

Ingredients: Cereals (70%) (wheat, oat bran, barley), psyllium husk (1%), sugar, rice, malt extract, honey, salt, vitamins.

Total Fat
General foods: **less than 10g per 100g.** Milk, yogurt and icecream: **less than 2g per 100g.** Cheese: **less than 15g per 100g**

Saturated Fat Aim for the lowest, per 100g. **Less than 3g per 100g** is best.
Other names for saturated fat: Animal fat/oil, beef fat, butter, chocolate, milk solids, coconut, coconut oil/milk/cream, copha, cream, ghee, dripping, lard, suet, palm oil, sour cream, vegetable shortening.

Fibre
Choose breads and cereals with **3g or more per serve**

Ingredients
Listed from greatest to smallest by weight. Use this to check the first three ingredients for items high in saturated fat, sodium (salt) or added sugar.

100g Column and Serving Size
If comparing nutrients in similar food products use the **per 100g column**. If calculating how much of a nutrient, or how many kilojoules you will actually eat, use the per serve column.

Sugars
If sugar content **per 100g is more than 15g**, check that sugar is not listed high on the ingredient list.
Other names for added sugar: Dextrose, fructose, glucose, golden syrup, honey, maple syrup, sucrose, malt, maltose, lactose, brown sugar, caster sugar, maple syrup, raw sugar, sucrose.

Sodium (Salt)
Food with **less than 400mg per 100g are good**, and **less than 120mg per 100g is best.**
Other names for salt: Baking powder, celery salt, garlic salt, meat/yeast extract, monosodium glutamate (MSG), onion salt, rock salt, , sea salt, sodium, sodium ascorbate, sodium bicarbonate, sodium nitrate/nitrite, stock cubes, vegetable salt.

Source: National Health and Medical Research Council

Health monthly activity planner

Start Date:	My goal this week:
My long term goal:	

1. Plan what you will do. 2 . Photocopy the page for future use. 3. Put a tick in the box each day you do that activity for the next 4 weeks.

	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa
Fitness Activities – Aim to do something from this group for at least 30 minutes (ie 1x30, 2x15 or 3x10 minutes) on most days of the week																												
Walk																												
Work in the garden																												
*Add other activities here (eg swim, golf)																												
•																												
•																												
•																												
Strength Exercises *(pages 15-19)* – Try to do one of these activities on at least 3 days each week																												
Strength exercises (pages 15-19)																												
*Add other activities here (eg stairs, yard work)																												
•																												
•																												
•																												
Flexibility *(page 13)* – Try to do some stretching exercises every day																												
Stretching exercises (page 12-14)																												
*Add other activities here (eg yoga, bowls)																												
•																												
•																												
•																												
Balance Exercises *(pages 15-17)* – Do these as often as you can																												
Practice balancing (pages 15-17)																												
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•																												
Sitting Less – Mark the days you make a real effort to reduce your sitting time																												
Sitting less																												
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Health monthly activity planner

Start Date:	My goal this week:
My long term goal:	

1. Plan what you will do. 2 . Photocopy the page for future use. 3. Put a tick in the box each day you do that activity for the next 4 weeks.

	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa	Su	M	Tu	W	Th	F	Sa
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APAN exercise charts:

Your Exercise Chart

Warm up and Stretches | Strength & Balance Exercises

Warm up and Stretches - help improve your flexibility

Calf Stretch
- Bend your left knee and extend your right leg
- Press heel of your right foot into the floor
- Your left knee should not extend past your left toes
- Repeat with the opposite leg

Quadricep Stretch
- Bend right leg back. Use a wall or chair for support (if able, try and hold ankle or foot with right hand)
- Draw the knee and hip back towards your buttocks
- Release ankle or foot and slowly return to starting position
- Repeat with the opposite leg

Hamstring Stretch
- Keep your back straight
- Lift one leg and place heel on a step until you feel a stretch at the back of your thigh
- Repeat with the opposite leg

Overhead Stretch
- Clasp hands together with palms facing up
- Slowly lift your hands as high as you can above your head
- Unclasp hands and slowly lower arms to your sides
- Repeat

Shoulder Stretch
- Bring right arm across chest, place left hand onto right elbow
- Slowly return to starting position
- Repeat with the opposite arm

Triceps Stretch
- Lift left arm overhead keeping elbow close to your ear
- Grasp your left elbow with your right hand and bend left arm towards your back
- Gently push elbow down until a slight stretch is felt
- Slowly return to starting position
- Repeat with the opposite arm

Neck Stretch
- Slowly turn head to the right and then to the left
- Hold for 15-20 seconds on each side

Forearm Stretch
- Hold your right arm in front of you, palm down
- Place left hand on top of right fingers and gently bend them downwards, hold stretch
- Repeat with opposite arm
- Again, hold right arm in front of you, palm down
- Place left hand under right fingers and gently bend them backwards, hold stretch
- Repeat with opposite arm

Side Flexion
- Slide your right hand down your right leg. Allow your head to follow and left arm to slide up left side of your body
- Hold for 5 seconds
- Repeat with opposite hand

Handy Tips:
- Start with 5 minute warm-up at the beginning and cool down at the end
- Try to slowly build up the number of repetitions for each exercise and the number of sets you complete
- Over time, aim to do the program 3 days a week
- Make sure you drink water during and after exercising

Please Note:
- If you feel unusual pain, please stop the exercise program and see your Doctor
- Chat to your Program Ambassador about varying your exercise program to best suit your needs

Strength & Balance Exercises

Slowly build up to 8-12 repetitions for each exercise (one set). Gradually increase to 3 sets. No time? Try doing red exercises one day and blue exercises another day

HEALTH APAN medicare local Curtin University

Leg Extension
- Lie on back with knees bent, feet shoulder-width apart
- Slowly straighten one leg (keep toes pointed) lift then return to starting position
- Repeat with the opposite leg

Two-Arm Row
- Wrap resistance band around a strong door knob, rail or pole. Hold each end of the resistance band, stand with feet shoulder-width apart
- Keep elbows close to your body at the side. Arms bent at 90° angles
- Pull to bring your hands to the side of your body. Hold for 2 seconds
- Return to the starting position and repeat 8–12 times

Tricep Kickback
- Wrap resistance band around a strong door knob, rail or pole. Hold each end of the resistance band, stand with feet shoulder-width apart
- Face palms inwards and keep elbows close to your body at the side. Arms bent at 90° angles
- Straighten elbow to bring hand just behind your body. Hold for 2 seconds
- Return to the starting position and repeat 8–12 times with each arm

Side Leg Raise
- Keep back straight - use a wall or rail for support
- Slowly lift one leg out to the side
- Slowly return to starting the position
- Repeat with the opposite leg

Wall Pushups
- Palms flat against the wall or rail at shoulder height. Keep back straight and stomach muscles strong
- Bend at the elbows and lower your body towards the wall/rail until your elbows are at 90° angles
- Slowly return to starting position and repeat

Biceps Curl
- Hold each end of the resistance band in your hands and stand on it with your feet shoulder-width apart
- Face palms forward and keep elbows close to your body at the side. Bend elbows, bring hands towards your shoulders. Hold for 2 seconds
- Return to the starting position and repeat 8–12 times

Toe Stand
- Use wall or rail for support, stand with feet shoulder-width apart
- Back straight slowly lift heels, hold 2-4 seconds and repeat

Assisted Squat
- Using chair or rail for support, stand with feet shoulder-width apart
- Keep back straight, bend knees and slowly lower buttocks towards the floor (make sure your front knee does not cover your toes)
- Slowly return to starting position and repeat.

Step Ups
- Stand away from a very low wall or step, with your feet shoulder-width apart. You may wish to use a wall or rail for support
- Keep back straight, step-up, one leg at a time (place entire foot on low wall or step). Stand up tall, and then slowly return to the start position
- Repeat 8–12 times with each leg

Your Exercise Chart

TV Exercises | Kettle Exercises

TV Exercises - these can be done while you watch TV

Chair Raise *(for strength and balance)*
- Sit on a chair with your feet flat on the floor and slightly apart
- Try to keep your back and shoulders straight throughout this exercise
- Slowly stand up, trying not to use your hands (or as little as possible)
- Slowly sit back down and pause
- Do this 8-15 times

Neck Roll *(for flexibility)*
- Slowly roll your head in a gentle circular motion
- Do this slowly 5 times, then reverse the direction

Knee Lift (for strength)
- Sit back in your chair with your back straight
- Bend your knee and lift your left leg towards your chest
- Hold for a few seconds then lower slowly
- Do this 8-10 times with each leg

Heels Up Toes Up *(for flexibility)*
- Start with feet flat on the floor and lift heels as high as you can, keeping the balls of your feet on the floor
- Slowly lower heels until feet are flat, then lift toes until they point upwards
- Repeat these up and down movements for 30 seconds

Handy Tips:
- Start with 5 minute warm-up at the beginning and cool down at the end
- Try to slowly build up the number of repetitions for each exercise and the number of sets you complete
- Over time, aim to do the program 3 days a week
- Make sure you drink water during and after exercising

Please Note:
- If you feel unusual pain, please stop the exercise program and see your Doctor
- Chat to your Program Ambassador about varying your exercise program to best suit your needs

Kettle Exercises - these can be done while the kettle is boiling

Assisted Heel-Toe *(for balance)*
- Stand next to a support and step forward by putting the heel of one foot directly in front of the toes of the other foot, so that they touch (or almost touch)
- If you can do this easily without holding on, try it with your eyes shut. Have someone stand next to you to support you if you need help. Do this 8-10 times with each leg

Assisted Squat *(improves leg strength)*
- Stand facing the wall or bench with your feet shoulder-width apart, feet facing forward and holding on with both hands
- Leaning very slightly forward, but keeping your back straight, slowly bend both legs, keeping your knees over your feet. Do not go down too far
- As you return to the up position, squeeze your buttocks together
- Repeat 8 times at first, increasing to 15

Heel Raise *(for strength and balance)*
- Stand with feet shoulder-width apart holding on with one hand to support yourself
- Slowly rise up on to your toes, hold for one second and lower again
- Do this 8 times to begin with, increasing to 15. Make sure your movements are not rushed

Side Leg Raise *(for strength and balance)*
- Stand sideways to the bench and hold on with your right hand to support yourself
- Slowly take your left leg out to your left side Keep your back and both legs straight
- Hold the position for one second then slowly lower. Repeat 8 times at first, increasing to 15
- Turn around and hold on with your left hand while you raise your right leg

Assisted Stand on One Foot
(for strength and balance
- Using a chair, rail or wall for support, stand with your feet shoulder-width apart
- At first use two hands for support, once you feel more stable use one hand
- Keeping your back straight, lift your left heel so just your toes are touching the ground
- When you feel stable, slowly lift your left leg so that your ankle is as high as your knee, keep toes pointed
- Repeat with the other leg. Do this 8-10 times with each leg

HEALTH PROMOTION RESEARCH
APAN Allianz Physical Activity & Nutrition
medicare local
Curtin University

APAN nutrition panel wallet cards:

READING NUTRITION PANELS

TOTAL FAT General foods: less than **10g per 100g**. Milk, yogurt and ice cream: less than **2g per 100g**. Cheese: less than **15g per 100g**

SATURATED FAT Aim for the lowest, per 100g. Less than **3g per 100g is best**.
Other names for saturated fat: Animal fat/ oil, beef fat, butter, chocolate, milk solids, coconut, coconut oil/milk/cream, copha, cream, ghee, dripping, lard, suet, palm oil, sour cream, vegetable shortening.

FIBRE Choose breads and cereals with **3g or more per serve**

INGREDIENTS Listed from greatest to smallest by weight. Use this to check the first three ingredients for items high in saturated fat, sodium (salt) or added sugar.

Source: National Health and Medical Research Council

APAN Curtin University

READING NUTRITION PANELS

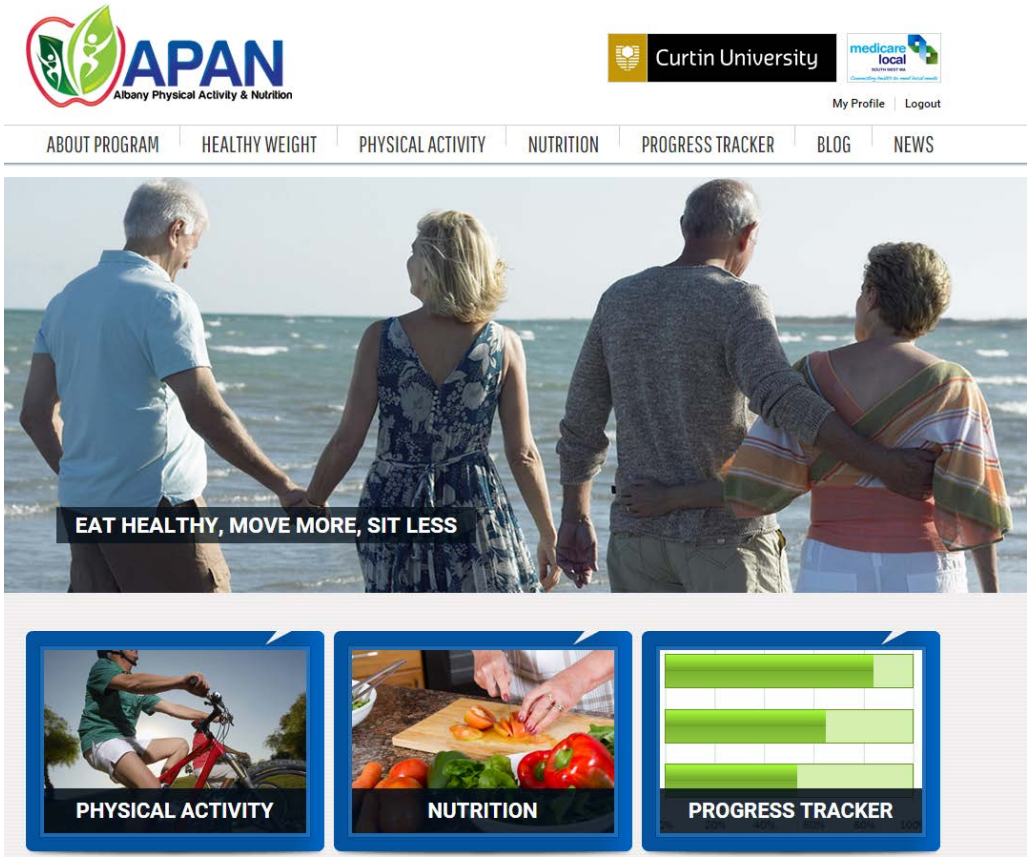
SUGARS If sugar content per **100g is more than 15g**, check that sugar is not listed high on the ingredient list.
Other names for added sugar: Dextrose, fructose, glucose, golden syrup, honey, maple syrup, sucrose, malt, maltose, lactose, brown sugar, caster sugar, maple syrup, raw sugar, sucrose.

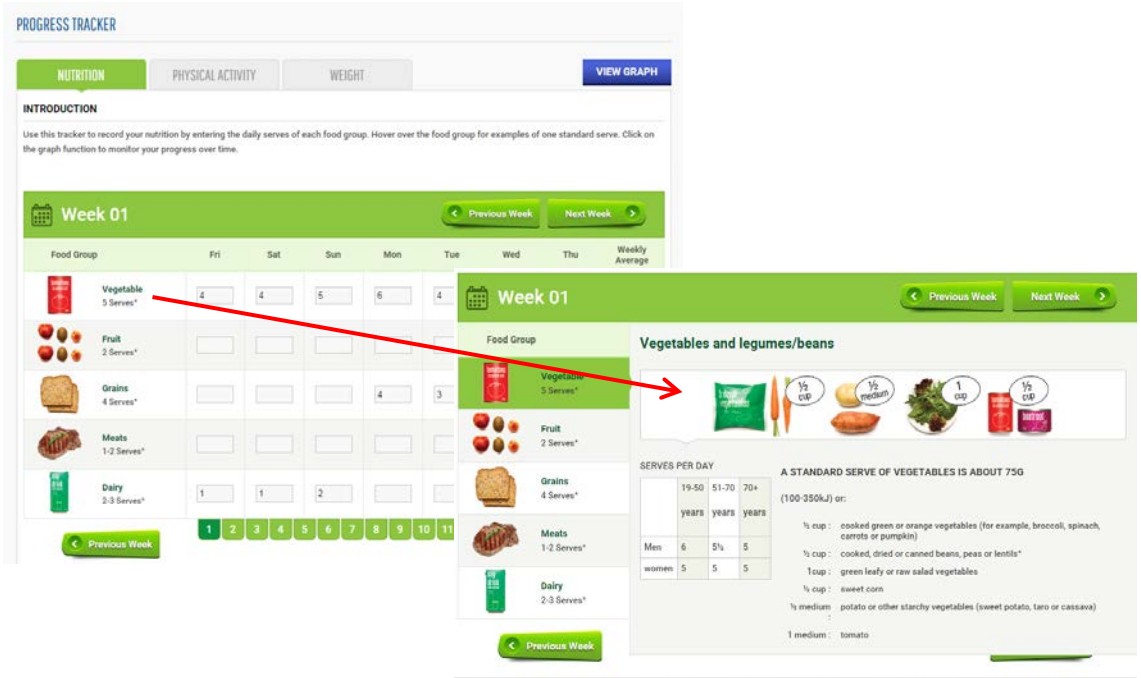
SODIUM (SALT) Food with less than **400mg per 100g are good, and less than 120mg per 100g is best**.
Other names for salt: Baking powder, celery salt, garlic salt, meat/yeast extract, monosodium glutamate (MSG), onion salt, rock salt, sea salt, sodium, sodium ascorbate, sodium bicarbonate, sodium nitrate/nitrite, stock cubes, vegetable salt.

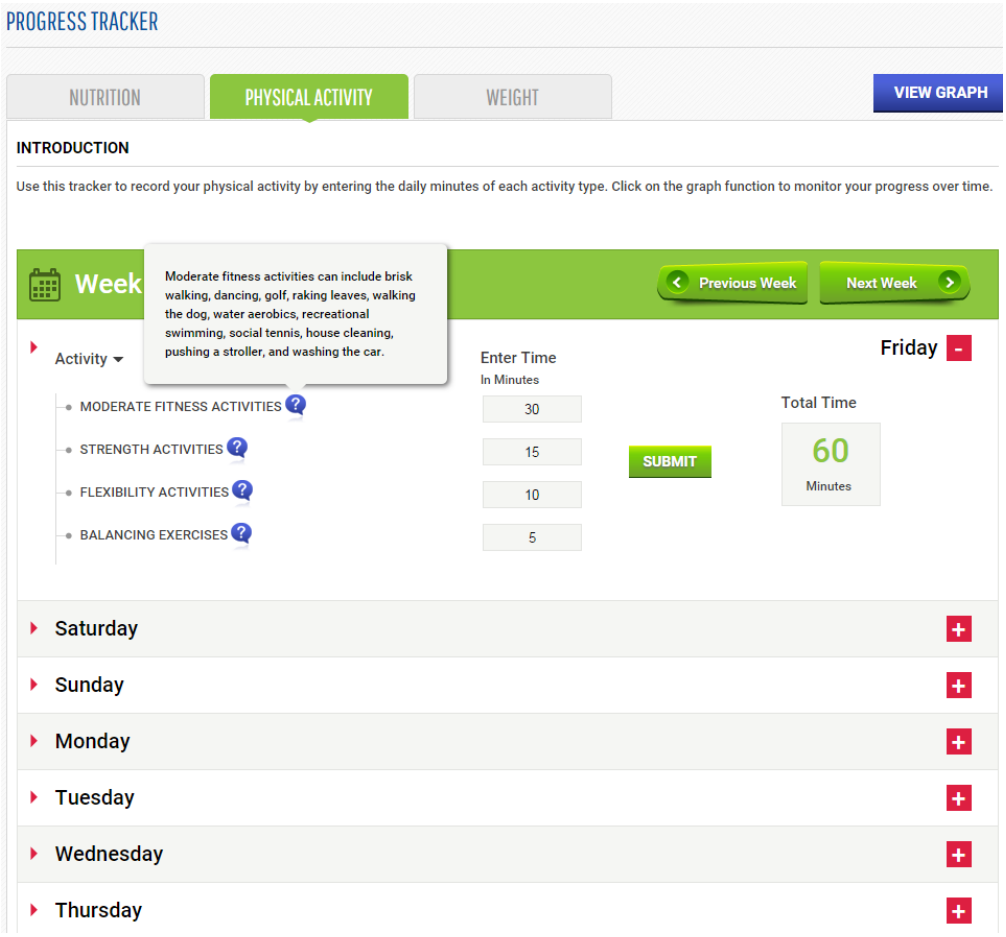
Source: National Health and Medical Research Council

APAN Curtin University

APAN website and progress tracker:






PROGRESS TRACKER
NUTRITION
PHYSICAL ACTIVITY
WEIGHT
VIEW GRAPH
INTRODUCTION
Use this tracker to record your physical activity by entering the daily minutes of each activity type. Click on the graph function to monitor your progress over time.
Week
Moderate fitness activities can include brisk walking, dancing, golf, raking leaves, walking the dog, water aerobics, recreational swimming, social tennis, house cleaning, pushing a stroller, and washing the car.
Previous Week
Next Week
Activity
Enter Time
In Minutes
Friday
MODERATE FITNESS ACTIVITIES
30
STRENGTH ACTIVITIES
15
FLEXIBILITY ACTIVITIES
10
BALANCING EXERCISES
5
SUBMIT
Total Time
60
Minutes
Saturday
Sunday
Monday
Tuesday
Wednesday
Thursday

BLOG

ARE YOU AT RISK?

Oct,15 2014 | | By Apanadmin

Gaining weight doesn't have to be an inevitable part of getting older. Maintaining a healthy weight is one of the best things you can do to reduce your risk of developing chronic disease. What is chronic disease? Chronic diseases are defined as such because they are l...

WHY FRUIT & VEG?

Oct,2 2014 | | By Apanadmin

Most Australian adults don't eat enough fruit and vegetables. It is recommended that we eat at 2 serves of fruit and 5 serves of vegetables each day to maintain a healthy weight and reduce our risk of chronic diseases such as type 2 diabetes and cardiovascular disease...

SEDENTARY BEHAVIOUR AND PHYSICAL INACTIVITY – WHAT'S THE DIFFERENCE?

ul,29 2014 | | By Apanadmin

Sedentary behaviour (with the exception of sleeping), includes sitting or lying down. Activities at work, school, home, whilst travelling, or during leisure time can be sedentary behaviours. Sedentary behaviour requires little energy expenditure. There is a difference b...

WELCOME TO NEW APAN PARTICIPANTS

Jul,16 2014 | | By Apanadmin

Congratulations! You have become part of an exciting new program designed to promote a healthy lifestyle. On behalf of the APAN team, welcome to the program. We look forward to assisting you with lifestyle changes to work towards a healthy weight, improved energy, and g...

Appendix H: Process evaluation instruments

APAN Materials Evaluation

Introduction

Thank you for participating in the Albany Physical Activity & Nutrition (APAN) Program. So that we can improve the APAN Program, we would value your feedback on some of the materials provided. By completing this survey, you will be entered into the draw for a $100 Target voucher.

***1. I agree to participate in this survey.**

- Yes
- No

Booklet Evaluation

This section will ask you to provide feedback on the APAN Booklet.

***2. How useful do you find the APAN booklet?**

	Very useful		Neutral		Not very useful
Usefulness	Usefulness Very useful	Usefulness	Usefulness Neutral	Usefulness	Usefulness Not very useful

***3. How eye catching/attractive do you find the APAN booklet?**

	Very eye catching/attractive		Neutral		Not very eye catching/attractive
Attractiveness	Attractiveness Very eye catching/attractive	Attractiveness	Attractiveness Neutral	Attractiveness	Attractiveness Not very eye catching/attractive

***4. How suitable is the APAN booklet to people your age?**

	Very suitable		Neutral		Not very suitable
Suitability	Suitability Very suitable	Suitability	Suitability Neutral	Suitability	Suitability Not very suitable

***5. To what extent has the APAN booklet encouraged you to be physically active?**

	It has encouraged me to be physically active		Neutral		It has not encouraged me to be physically active
Level of encouragement	Level of encouragement It has encouraged me to be physically active	Level of encouragement	Level of encouragement Neutral	Level of encouragement	Level of encouragement It has not encouraged me to be physically active

***6. To what extent has the APAN booklet encouraged you to practice the APAN exercises?**

	It has encouraged me to practice the APAN exercises		Neutral		It has not encouraged me to practice the APAN exercises
Level of encouragement	Level of encouragement It has encouraged me to practice the APAN exercises	Level of encouragement	Level of encouragement Neutral	Level of encouragement	Level of encouragement It has not encouraged me to practice the APAN exercises

***7. To what extent has the APAN booklet encouraged you to eat more fruit & vegetables?**

	It has encouraged me to eat more fruit & vegetables		Neutral		It has not encouraged me to eat more fruit & vegetables
Level of encouragement	Level of encouragement It has encouraged me to eat more fruit & vegetables	Level of encouragement	Level of encouragement Neutral	Level of encouragement	Level of encouragement It has not encouraged me to eat more fruit & vegetables

***8. To what extent has the APAN booklet encouraged you to eat less sugar, fat, and salt?**

	It has encouraged me to eat less sugar, fat, and salt				It has not encouraged me to eat less sugar, fat, and salt
Level of encouragement	Level of encouragement It has encouraged me to eat less sugar, fat, and salt	Level of encouragement	Level of encouragement	Level of encouragement	Level of encouragement It has not encouraged me to eat less sugar, fat, and salt

9. Was there anything you particularly liked about the APAN booklet?

10. Was there anything you particularly disliked about the APAN booklet?

11. Do you have any suggestions to improve the APAN booklet?

***12. Did you use the monthly activity planner?**

- Yes
- No

13. If no, why didn't you use it?

Exercise Chart Evaluation

This section will ask you to provide feedback on the APAN Exercise Chart.

***14. How useful do you find the APAN exercise chart?**

	Very useful		Neutral		Not very useful
Usefulness	Usefulness Very useful	Usefulness	Usefulness Neutral	Usefulness	Usefulness Not very useful

***15. How eye catching/attractive do you find the APAN exercise chart?**

	Very eye catching/attractive		Neutral		Not very eye catching/attractive
Attractiveness	Attractiveness Very eye catching/attractive	Attractiveness	Attractiveness Neutral	Attractiveness	Attractiveness Not very eye catching/attractive

***16. How suitable is the APAN exercise chart to people your age?**

	Very suitable		Neutral		Not very suitable
Suitability	Suitability Very suitable	Suitability	Suitability Neutral	Suitability	Suitability Not very suitable

***17. To what extent has the APAN exercise chart encouraged you to be physically active?**

	It has encouraged me to be physically active		Neutral		It has not encouraged me to be physically active
Level of encouragement	Level of encouragement It has encouraged me to be physically active	Level of encouragement	Level of encouragement Neutral	Level of encouragement	Level of encouragement It has not encouraged me to be physically active

***18. To what extent has the APAN exercise chart encouraged you to practice the APAN exercises?**

	It has encouraged me to practice the APAN exercises		Neutral		It has not encouraged me to practice the APAN exercises
Level of encouragement	Level of encouragement It has encouraged me to practice the APAN exercises	Level of encouragement	Level of encouragement Neutral	Level of encouragement	Level of encouragement It has not encouraged me to practice the APAN exercises

19. Was there anything you particularly liked about the APAN exercise chart?

20. Was there anything you particularly disliked about the APAN exercise chart?

21. Do you have any suggestions to improve the APAN exercise chart?

Website Evaluation

This section will ask you to provide feedback on the APAN Website.

***22. How useful do you find the APAN website?**

	Very useful		Neutral		Not very useful
Usefulness	Usefulness Very useful	Usefulness	Usefulness Neutral	Usefulness	Usefulness Not very useful

***23. How eye catching/attractive do you find the APAN website?**

	Very eye catching/attractive		Neutral		Not very eye catching/attractive
Attractiveness	Attractiveness Very eye catching/attractive	Attractiveness	Attractiveness Neutral	Attractiveness	Attractiveness Not very eye catching/attractive

***24. How suitable is the APAN website to people your age?**

	Very suitable		Neutral		Not very suitable
Suitability	Suitability Very suitable	Suitability	Suitability Neutral	Suitability	Suitability Not very suitable

***25. To what extent has the APAN website encouraged you to be physically active?**

	It has encouraged me to be physically active		Neutral		It has not encouraged me to be physically active
Level of encouragement	Level of encouragement It has encouraged me to be physically active	Level of encouragement	Level of encouragement Neutral	Level of encouragement	Level of encouragement It has not encouraged me to be physically active

***26. To what extent has the APAN website encouraged you to practice the APAN exercises?**

	It has encouraged me to practice the APAN exercises		Neutral		It has not encouraged me to practice the APAN exercises
Level of encouragement	Level of encouragement It has encouraged me to practice the APAN exercises	Level of encouragement	Level of encouragement Neutral	Level of encouragement	Level of encouragement It has not encouraged me to practice the APAN exercises

***27. To what extent has the APAN website encouraged you to eat more fruit & vegetables?**

	It has encouraged me to eat more fruit & vegetables		Neutral		It has not encouraged me to eat more fruit & vegetables
Level of encouragement	Level of encouragement It has encouraged me to eat more fruit & vegetables	Level of encouragement	Level of encouragement Neutral	Level of encouragement	Level of encouragement It has not encouraged me to eat more fruit & vegetables

***28. To what extent has the APAN website encouraged you to eat less sugar, fat, and salt?**

	It has encouraged me to eat less sugar, fat, and salt				It has not encouraged me to eat less sugar, fat, and salt
Level of encouragement	Level of encouragement It has encouraged me to eat less sugar, fat, and salt	Level of encouragement	Level of encouragement	Level of encouragement	Level of encouragement It has not encouraged me to eat less sugar, fat, and salt

29. Was there anything you particularly liked about the APAN website?

30. Was there anything you particularly disliked about the APAN website?

31. Do you have any suggestions to improve the APAN website?

***32. Did you use the nutrition/physical activity progress tracker?**

- Yes
- No

33. If no, why didn't you use it?

Thank you

Thank you for taking the time to complete this survey.

34. To enter the draw for a $100 Target voucher, please enter your email address below.

Participant ID: _____

APAN Program Exit Interviews: Completers

Objectives:

1. **To identify reasons for being in the APAN program.**
2. **To identify the design features of APAN that encouraged participation.**
3. **To evaluate and identify the guidance and support (motivational cues/triggers) provided by the program mentors during APAN.**
4. **To establish changes in attitudes/behaviours to physical activity and eating habits during the APAN program (6 months).**
5. **To identify how APAN program may be improved.**

Method: Qualitative interviews conducted via telephone.

Interviewer Introduction:

Introduce yourself and reasons for conducting this 20 minute interview.

We are conducting short interviews with some of our APAN participants who successfully completed the six month program. We want to find out your opinions on the program itself as well as feedback on the guidance and support you received from your Program mentor. Thanks for your time and agreeing to participate.

Reasons for being involved in APAN.

Firstly, I'd like to talk to you about why you decided to become involved in the APAN program.

1. Overall, what were the **reasons for becoming involved** in the APAN program?

_____
_____
_____
_____
_____

Design features of the APAN program

Now, I'd like to talk to you about the design features of APAN (home-based program, booklet, exercise charts, website). I would like your opinions/feedback on the components of the program that you like/disliked.

1. What did you think of the **APAN program overall**? (prompt – *'home-based' 'web site'*)

_____
_____
_____
_____
_____

2. What did you think of the APAN program **booklet, exercise charts, website** overall? (prompt – booklet –website information content, readability, back page planner; exercise charts – clarity of instructions/photos; use of resistance band; website –content, frequency)

_____
_____
_____
_____
_____

3. Do you have any suggestions to **improve** the program materials (booklet, exercise charts, website)?

_____
_____
_____
_____
_____

Program Mentor – guidance and support

We would like to get some feedback on the guidance and support you received from your Program Mentor (Jane or Tracy).

1. Approximately, **how many times** did your Program Mentor contact you over the six months you were participating in the APAN Program?

_____ times/6 months

2. How would you **rate the guidance/support** you received using a scale of 1 - 10? *1 = not sufficient and 10 = sufficient.*

1……2……3……4……5……6……7……8……9……10

I'd like to gain your opinions on the guidance/support you received. By this I mean goal setting/ motivation to keep going, rather than the Program Mentor herself.

3. What did you **like** about the guidance/support you received?

_____
_____
_____
_____
_____

4. What did you **dislike** about the guidance/support you received?

Changes in attitudes and behaviours to physical activity and eating habits

I would now like to ask you about your attitude to physical activity since starting the APAN program.

1. Do you think the program encouraged you to **increase** you levels of physical activity? Why or why not?

---

2. Did you **walk** more/less/didn't walk over the six months you were participating in the program? Why or why not?

---

3. Did you use the **APAN exercises** (in the booklet and chart lift-outs)? Why or why not?

---

4. Have you tried any **different types of physical activity** since starting the APAN program (for example, aqua classes, yoga, dancing etc)? Please list.

I would now like to ask you about changes in your eating habits since starting the APAN program.

5. Do you think the program **encouraged** you to make any changes to your eating habits? Why or why not?

6. Do you think the APAN program encouraged you to find out **more information** about food/nutrition? Why or why not?

7. Are there any **changes** you made to your diet since starting the APAN program? Please list?

Finally, I would like to ask you your reasons for completing the program.

1. What **motivated** you the most to complete the program?

2. How do you think we could make the program **more appealing** to your age group?

3. Can you suggest how **the APAN program can be improved?**

_____
_____
_____
_____
_____

4. Are there any **other comments** you would like to make?

_____
_____
_____
_____
_____

Thank you for your time. Your feedback provides valuable information regarding the program.

APAN PROGRAM Exit Interviews: Non-Completers

Objectives:

1. **To identify reasons for being in the APAN program.**
2. **To identify reasons for not continuing in the APAN program.**
3. **To identify how the APAN program can be improved.**

Method: Qualitative interviews conducted via telephone.

Interviewer Introduction:

Introduce yourself and reasons for conducting this 20 minute interview.

We are conducting short interviews with some of our APAN participants who successfully completed the six month program. We want to find out your opinions on the program itself as well as feedback on the guidance and support you received from your Program Mentor. Thanks for your time and agreeing to participate.

Reasons for being involved in the APAN program

Firstly, I'd like to talk to you about why you decided to become involved in the APAN program.

1. Overall, what were the **reasons for becoming involved** in the APAN program?

_____
_____
_____
_____
_____

2. How **long did you participate** in the program for?

_____
_____
_____
_____
_____

Reasons for not being involved in the APAN program

I would like to talk to you about why you did not participate in the program for six months.

1. Would you like to tell me the **reasons for not continuing** the program? (*Optional – may not want to disclose. Move to next question)

_____
_____
_____
_____
_____

2. Are there any aspects of the program itself you **did not like**?

_____
_____
_____
_____
_____

3. Are there any aspects of the program itself you **did like**?

_____
_____
_____
_____
_____

Program Resources (booklet, exercise charts, newsletters website)

Now, I would like to talk to you about the program resources (booklet, exercise charts, website).

1. What did you think of the **program resources overall** (booklet, exercise charts, website)?

_____
_____
_____
_____
_____

2. Do you have any suggestions to **improve** the program resources (booklet, exercise charts, website)?

_____
_____
_____
_____
_____

Program Mentor – guidance and support

We would like to get some feedback on the guidance and support you received from your Program Mentor (Tracy or Jane).

1. Approximately, **how many times** did your Program Ambassador contact you over the period you were participating in APAN Program?

_____ times/6 months

2. How would you **rate the guidance/support** you received using a scale of 1 - 10? *1 = not sufficient and 10 = sufficient.*

1.....2.....3.....4.....5.....6.....7.....8.....9.....10

I'd like to gain your opinions on the guidance/support you received. By this I mean goal setting/ motivation to keep going, rather than the Program Mentor himself/herself.

3. What did you **like** about the guidance/support you received?

---

4. What did you **dislike** about the guidance/support you received?

Finally, I would like to gain feedback on how we could have encouraged you to stay in the program. (*Optional – see above)

1. What could we have done to **encourage you to stay** with the program?

---

2. Can you suggest how **the APAN program can be improved**?

---

3. Are there any **other comments** you would like to make about the APAN program?

Thank you for your time. Your feedback provides valuable information regarding the program.

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