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Theoretical underpinnings of a need-supportive intervention to address sustained healthy lifestyle changes in overweight and obese adolescents

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Theoretical Underpinnings of a Need-Supportive Intervention to Address Sustained Healthy Lifestyle Changes in Overweight and Obese Adolescents

Rates of overweight and obesity in Australian adolescents have doubled in the past 25 years (Olds, Tomkinson, Ferrar, & Maher, 2009), with current figures indicating one in four adolescents are overweight or obese (Australian Bureau of Statistics, 2012). Adolescent obesity is a major public health concern because of the associated negative health outcomes including type 2 diabetes (Tirosh et al., 2011), cardiovascular risk factors (Sorof, Lai, Turner, Poffenbarger, & Portman, 2004), social marginalization (Strauss & Pollack, 2003), depression (Luppino et al., 2010), and anxiety (Rofey, Kolko, & Iosif, 2009). Obesity during adolescence is also highly predictive of adult obesity (Freedman et al., 2005) and continued persistence of physical and psychosocial consequences.

Although increases in physical activity and healthy eating behaviors have been shown to be effective in promoting positive health outcomes (Berkey, Rockett, Gillman, & Colditz, 2003; Bradlee, Singer, Qureshi, & Moore, 2010), only 57% of Australian adolescents meet national guidelines for physical activity (Hardy, 2010), and fewer than a quarter meet guidelines for fruit (23%) and vegetable intake (15%; Australian Bureau of Statistics, 2009). These figures are of particular concern given that behaviors formed in adolescence underpin lifelong behavioral patterns (Story, Neumark-Sztainer, & French, 2002). In response, health related agencies worldwide have called for programs to increase adolescents' physical activity and healthy eating behaviors. However, there remains a relative dearth of programs demonstrating long-term maintenance of these behaviors (Currie et al., 2012).

Evidence suggests that if interventions are to be effective in the long-term, adolescents must be targeted within the family context (Shrewsbury, Steinbeck, Torvaldsen, & Baur, 2011). The inclusion of modifying parent behaviors to support adolescents' behavior changes is paramount given parents are a primary stakeholder regarding the provision of environments

that foster adolescents' uptake and maintenance of healthy lifestyle behaviors (Pearson, Biddle, & Gorely, 2009). Environmental contributions include not only the provision of physical resources such as purchasing healthy food items (Hanson, Neumark-Sztainer, Eisenberg, Story, & Wall, 2005), but also refer to the demonstration of behaviors associated with adolescents' motivation to engage in healthy lifestyle behaviors including joint participation in physical activity (Bauer, Neumark-Sztainer, Fulkerson, Hannan, & Story, 2011), parent behavior modeling (Davison, Francis, & Birch, 2005), less controlling food environments (Birch, Fisher, & Davison, 2003), and supporting adolescents' behavior choices (Hagger et al., 2009). Interventions targeting families must therefore address evidence-based motivational techniques aimed at fostering adolescents' behavior changes and parents' behaviors to support these choices both within the context of intervention settings and home environments (Oude Luttikhuis et al., 2009).

Two theories of motivation that have been identified as showing some promise in promoting sustained behavior change include self-determination theory (Deci & Ryan, 2000) and goal setting theory (Locke & Latham, 1990). Despite evidence supporting interventions based on these theoretical underpinnings (Shilts, Townsend, & Dishman, 2013; Van den Berghe, Vansteenkiste, Cardon, Kirk, & Haerens, 2012), methodological shortcomings exist in the current literature that may limit the capacity of each theory to contribute to the development of behavior change interventions. Firstly, although each theory alone has been shown to effectively inform interventions to change behavior, researchers have yet to combine these motivational theories in a healthy lifestyle intervention. Integrating both theories is likely to optimize behavioral engagement by providing a framework for intervention content that not only focuses on the types of goals set according to goal-setting theory but also on the content and motivational perspective of the goals based on self-determination theory. Such an approach will permit the setting of goals that are closely

aligned with individuals' self-determined motivational orientations and, therefore, more likely to be enacted as self-determined motives are strongly linked with self-regulation and behavioural persistence. Secondly, of the studies reporting on the independent effects of each theory, a scant number exist that contain a sufficient level of detail to allow for effective evaluation and replication of behavior-change techniques (Shilts, et al., 2013). In response, researchers have increasingly called for a need to improve the reporting of intervention content to help streamline the implementation of evidence-based behavior techniques (Abraham & Michie, 2008; Bartholomew, Parcel, Kok, Gottlieb, & Fernández, 2011). In keeping with this call for greater disclosure of intervention content detail, the current article will describe the theoretical underpinnings and associated evidence-based behavior-change techniques of a multi-disciplinary family-based healthy lifestyle behavioral intervention, Curtin University's Activity, Food and Attitudes Program (CAFAP), designed to facilitate a more self-determined style of motivation required for behavior maintenance (Hagger, Chatzisarantis, Culverhouse, & Biddle, 2003). This will be achieved by 1) demonstrating how self-determination theory and goal setting theory were integrated to inform the selection of specific behavior-change techniques, and by 2) describing program components at a level that provides a rationale for the potential effectiveness of the intervention and allows for the replication of behavior-change techniques in other contexts (Abraham & Michie, 2008; Michie & Abraham, 2004).

Objectives

Objectives of the current paper will be accomplished by building on CAFAP's previously described overarching rationale and framework (Straker et al., 2012) to allow for a comprehensive description of theoretical rationale and delivery of behavior-change techniques specific to processes of motivation that are critical for the future development of effective interventions.

A primary objective of the current article is to describe the development of a protocol that trains instructors to modify intervention environments by engaging in behaviors shown to enhance self-determined motivation, and to describe methods for training instructors to teach parents how to demonstrate these behaviors in their interactions with adolescents. Adolescents' perception of instructors' and parents' demonstration of these behaviors is hypothesized to positively predict their levels of self-determined motivation and subsequent engagement in physical activity and healthy eating behaviors. Instructors' provision of these behaviors during program sessions is further hypothesized to increase parents' level of self-determined motivation to perform behaviors to support adolescents' engagement in healthy lifestyle behaviors, which, in turn, will increase adolescents' behavior engagement.

A secondary objective is to describe the theoretical underpinnings of a goal setting structure based on the integration of self-determination theory and goal setting theory. Specifically, components of goal setting theory will be applied to provide a motivational framework for adolescents and parents to implement their self-determined behavior changes. Adolescent goal setting will address their healthy lifestyle behavior changes and parent goal setting will map support behaviors for parents to carry out that align with adolescents' behavior change goals. We then aim to further enhance benefits of goal setting techniques by structuring intervention environments to encourage setting goals related to self-determined reasons such as enjoyment and adolescent-centered health outcomes.

Theoretical Rationale

In this section we outline the theoretical rationale behind the components of the intervention. We begin our analysis with an overview of the salient aspects of self-determination theory and how these have informed the development of behavior change intervention in health behavior. We then describe goal setting theory and how the integration of self-determination theory components alongside methods from goal setting theory will

generate an intervention protocol that will maximize behavior change among obese and overweight adolescents in the proposed study.

Self-determination theory

Self-determination theory is based on the key premise that motivation to perform a behavior varies according to the degree to which a behavior is self-determined (Deci & Ryan, 2000). These varying motivational styles or *regulations* are organized along a continuum ranging from controlled (regulated by external forces) to autonomous (self-determined) regulation. *External regulation* is the most controlling form of motivation and refers to individuals performing a behavior to gain a reward or avoid punishment; *introjected regulation* involves performing behaviors due to internal pressures or compulsions; *identified regulation* entails people identifying with the value of a behavior but not necessarily enjoying the activity; *integrated regulation* involves accepting behaviors as congruent with personal values and interests, although the behavior is not performed solely out of interest; and i*ntrinsic motivation* is the prototypical form of self-determined motivation and involves engaging in activities out of inherent interest and enjoyment.

Autonomous motivation is considered important for sustained behavior change because it is hypothesized to lead individuals to engage in behaviors without the need for external reinforcement (Deci & Ryan, 2000). A primary objective in addressing behavior change is therefore to promote the internalization of regulations such that individuals' behaviors are reinforced intrinsically. Environmental factors are posited in self-determination theory to facilitate or inhibit internalization by satisfying or thwarting individuals' basic needs for autonomy, competence, and relatedness. *Autonomy* reflects the desire to be the origin of one's choices and behaviors in accordance with one's values; c*ompetence* involves one's desire to master effective interactions with the environment; and *relatedness* refers to the desire to feel connected to others in supportive social relationships. When all three needs

are met, individuals are more likely to engage in autonomously motivated behaviors (Deci & Ryan, 2000). Behavior change is thus explained as a reflection of the degree to which individuals' environments support their needs for autonomy, competence, and relatedness.

According to self-determination theory, individuals' need satisfaction can be optimized when environmental contexts provide three components: autonomy support, structure, and involvement (Deci & Ryan, 2000). Behaviors comprising each environmental component have been identified (Deci, Spiegel, Ryan, Koestner, & Kauffman, 1982; Reeve, Bolt, & Cai, 1999) and empirically tested (Chatzisarantis & Hagger, 2009), resulting in the following list of behaviors that social agents should adopt in order to change behavior. *Autonomy support* includes the promotion of choice and limited use of controlling demands by providing choices for activities, positive feedback regarding progress, being responsive to individuals' feelings and thoughts, and explaining rational for activities. Autonomy support directly supports autonomy and indirectly supports basic needs for competence and relatedness (Black & Deci, 2000). *Structure* provides direct support for individuals' competence (Deci & Ryan, 2000) and involves the provision of consistent guidelines for behavior by providing optimally challenging tasks, assistance to formulate realistic goals, and positive feedback regarding progress. *Involvement* directly facilitates relatedness (Deci & Ryan, 1991) and refers to social agents' display of support resources (e.g., physical, time) and interest in individuals' day-to-day pursuits.

Studies have demonstrated across a range of interactions (e.g., parents, friends, and physical education teachers) that when adolescents' environments comprise these need-supportive components, motivation guiding their engagement in healthy lifestyle behaviors is more likely to be self-determined (Hagger, et al., 2009; Standage & Gillison, 2007; Taylor & Ntoumanis, 2007), and behavior engagement increased as a result (Chatzisarantis & Hagger, 2009). The context surrounding adolescents' prescription of healthy behaviors generated by

significant others and social agents has thus become a key factor for interventions targeting the maintenance of long-term behavior changes.

Self-determination theory: Behavioral interventions

A central focus of studies exploring the feasibility of manipulating environmental contexts has been the modification of instructors' behaviors to provide need-support (Van den Berghe, et al., 2012; Verloigne et al., 2011). While these studies have been instrumental in demonstrating that provision of support for basic needs by instructors is a modifiable behavior that predicts increases in adolescents' engagement in healthy lifestyle behaviors, less attention has been afforded to modifying behaviors of additional key social agents, namely parents, within the context of self-determination theory. Addressing adolescents' motivation in the home environment is imperative if adolescents are to actualize motivations fostered in external settings (Twiddy, Wilson, Bryant, & Rudolf, 2012) and if they are to receive ongoing need-support beyond the scope of that experienced in a brief intervention.

Among the studies addressing parent behaviors in a healthy lifestyle context, results indicate parents are receptive to learning need-supportive behaviors, and autonomous forms of motivation and behavior engagement is increased in children as a result (Jago et al., 2013; Koulouglioti et al., 2013). However, these investigations were limited to parents of young children and assessments of parents' changes in motivation to engage in supportive behaviors were not explored. Motivation is particularly salient for parents of obese adolescents who are more likely to endorse a controlling orientation (Chiang & Padilla, 2012). Self-determination theory-based interventions conducted in adult samples suggest that parents' engagement in behaviors to support their adolescents is strongly associated with their motivation (Edmunds, Ntoumanis, & Duda, 2008; Silva et al., 2011), and therefore needs to be explored in relation to adolescent outcomes.

Limitations of prior family-based interventions grounded in self-determination theory are further confounded by the inability to draw conclusions regarding long-term behavior maintenance. Given the potential benefit of adolescents receiving ongoing need-support in the home environment as a result of parent training in behavior modifications, it is imperative to explore the associated long-term maintenance of parents' motivation to continue these behaviors and adolescents' associated engagement in healthy lifestyle behaviors. The current study seeks to address these limitations by assessing adolescents' physical activity and healthy eating behaviors as well as adolescents' and parents' behavior motivation over a one year period following intervention delivery (immediate post-program, 3, 6, and 12 month).

Goal setting theory

In addition to self-determination theory, theories of goal setting have been applied to explain motivation for task performance. Goal setting provides a structure for developing and implementing behavior-change plans, and has been shown to be an effective strategy for modifying physical activity and eating behaviors in adolescent (Matthews & Moran, 2011; Shilts, Horowitz, & Townsend, 2009) and adult samples (Locke & Latham, 1990; Shilts, Horowitz, & Townsend, 2004). Although intrinsic motivation has been shown to engender behavior engagement and persistence, providing individuals with goal-setting techniques alongside need-support to implement endorsed behaviors may further assist in promoting sustained behavior change.

The most prominent goal setting theory was developed by Locke and Latham (1990) and proposes that goal setting effects performance via three motivational mechanisms: effort, persistence, and concentration. These mechanisms are strengthened when set goals are broken down from distal goals into proximal goals that are difficult and specific. Proximal goals, or subgoals, make tasks appear more manageable while also providing frequent feedback regarding progress, which has been shown to increase self-efficacy (Latham &

Seijts, 1999; Stock & Cervone, 1990) and goal persistence (Latham & Seijts, 1999). Difficult goals are shown to be linearly related to performance, such that more effort is required as goal difficulty increases, which leads to greater performance in comparison to easy goals or "do your best" (Locke & Latham, 1990). Instances of failure are posited to be met with dissatisfaction and result in motivation to invest subsequent effort, concentration, and persistence when the goal is assumed to be attainable (Strecher et al., 1995). Recording specific details of each goal, such as the amount and frequency of a behavior (e.g., walk 1km a day five days a week), reduces ambiguity for evaluating performance and setting new goals and results in higher levels of performance (Locke & Latham, 1990).

Key to the success of goal setting as a motivational framework is the provision of content that allows for accurate uptake of goal setting processes (Strecher, et al., 1995). Collaborative goal setting has been suggested as a means for accomplishing successful learning and application of goal setting techniques (Bodenheimer & Handley, 2009) and entails jointly discussing goals to ensure they are appropriately matched in level of difficulty and clearly defined. Collaborative goal setting has been shown to be particularly salient for adolescents (Contento, Koch, Lee, & Calabrese-Barton, 2010) who are moving from the developmental stage of understanding concrete concepts to more abstract concepts (Carraça et al., 2011) required for goal setting (Standage, Gillison, Ntoumanis, & Treasure, 2012).

Given goal setting functions as a strategy for motivating behavior change while also providing a structure for implementing these changes, including goal setting methods is likely to provide optimal outcomes for sustained behavior change. Methods from goal setting theory will be adopted in the current study by asking adolescents and parents to set goals for their behavior changes using the previously reviewed techniques inclusive of proximal, specific, and difficult goals. Parent goals will reflect behavior changes in regard to their provision of resources to support adolescents' access to goals set for healthy lifestyle behavior changes

(e.g., purchasing fruit to assist adolescent's goal to eat one fruit serve/day). Collaboratively engaging both adolescents and parents in the goal setting process will also provide both a means for instructors to ensure goals are set appropriately and a check system for parents and adolescents to discuss the feasibility and implementation of goals in the home environment.

Integrating goal setting theory and self-determination theory

Motivational underpinnings of goal setting methods will be augmented by considering goal types proposed within self-determination theory. Within goal setting theory, goal success is posited to result from people's belief that goal attainment leads to value attainment, with no consideration given to the variability among reasons underlying goal strivings. In line with these propositions, meta-analyses have demonstrated that goal commitment, or one's expectancy of goal attainment, moderates the relationship between difficult goals and performance (Donovan & Radosevich, 1998; Klein, Wesson, Hollenbeck, & Alge, 1999). However, the authors concluded that alternative explanations may be at play given instances occur in which individuals with low expectancy are committed or those with high expectancy are not committed. Sheldon and colleagues (Sheldon & Elliot, 1999; Sheldon & Kasser, 1998) offered an alternative means for understanding the relationship between goal commitment and goal attainment by showing individuals' degree of internalization predicted attainment above and beyond commitment, which suggests that variations in goal attainment reflect individuals' need satisfaction (Sheldon, Turban, Brown, Barrick, & Judge, 2003).

Self-determination theory provides an explanation for such variations by considering goals as containing either *intrinsic* or *extrinsic* content. Intrinsic goals include goals such as health, self-acceptance, and affiliation, whereas extrinsic goals relate to appearance and wealth outcomes (Kasser, 2002). Intrinsic goals are proposed to satisfy basic psychological needs because they are inherently gratifying (Sheldon, Elliot, Kim, & Kasser, 2001), whereas extrinsic goals are contingent on acquiring external indicators of self-worth, which

undermines intrinsic motivation (Ryan & Deci, 2004). Placing greater value on extrinsic goal orientations (Kasser & Ryan, 1993, 1996; Sebire, Standage, & Vansteenkiste, 2009) and attaining these goals (Niemiec, Ryan, & Deci, 2009; Sheldon & Kasser, 1998) has been shown to predict negative health outcomes; whereas highlighting intrinsic goal importance (Kasser & Ryan, 1993) and goal attainment (Kasser & Ryan, 2001; Niemiec, et al., 2009) has been found to predict positive health outcomes.

Within the self-determination theory framework, the source of motivation or one's regulations for goal striving is also considered, such that the degree to which goal strivings are performed for autonomous or controlled reasons predicts behavioral outcomes. In line with this perspective, pursuing goals aligned with innate values and interests have been shown to promote goal attainment (Koestner, Otis, Powers, Pelletier, & Gagnon, 2008, Study 3; A. Smith, Ntoumanis, Duda, & Vansteenkiste, 2011) and sustained effort (Koestner, et al., 2008, Study 1; Sheldon & Elliot, 1999; Sheldon, et al., 2001) in comparison to controlled goal striving. This is because the goals are experienced as central to a person's genuine, non-contingent sense of self, which services basic needs and autonomous regulations. Although goal contents and goal regulations are both underpinned by need-satisfaction, recent evidence suggests psychological outcomes are independently predicted by goal contents and goal regulations (Sheldon, Ryan, Deci, & Kasser, 2004), whereas goal contents predict behavioral outcomes through goal regulations (Ingledew & Markland, 2008; Sebire, Standage, & Vansteenkiste, 2011). Considering both goal contents and goal regulations is thus likely to contribute to improved psychological and behavioral outcomes (Sebire, et al., 2009).

Goal framing has been a useful strategy in previous interventions to influence the uptake of more autonomous forms of behavior pursuit. Manipulations of goals in such instances have predominately focused on goal contents in regard to the uptake of novel activities in PE settings (Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004; Vansteenkiste,

Simons, Soenens, & Lens, 2004). In these studies, the intervention consisted of delivering a set of written instructions prior to task engagement. Although brief, results of the intervention demonstrated significant changes in intrinsic motivation, task persistence, and skill level in the week following intervention.

More recently, persistence of regularly-experienced activities in PE settings, as opposed to novel experiences, were investigated following a script read by the investigator that promoted intrinsic or extrinsic goal content in an environment that promoted choice or control. Results indicated manipulation of goal content and goal regulations in a single PE setting was not sufficient to shift motivation in regard to activities commonly experienced, which suggests repeated exposure to manipulations is needed to influence previously established behavior patterns (Cheon & Reeve, 2013). This shows that interventions aimed at modifying long-term behavior must employ continuous exposure to a goal setting framework that encourages participant choice and intrinsic goal contents.

Further, among studies manipulating goal contents and/or regulations, none asked participants to actively set their own behavior change goals. Instead, these studies have focused solely on framing goals for participants without consideration for self-generated goals or collaboratively set goals (Gillison, Standage, & Skevington, 2013). Given the widespread use of goal setting as a strategy for behavior change it is imperative to explore whether environmental contexts can influence participants to continuously set goals related to health outcomes motivated by personal values and enjoyment. Combining the tenets of self-determination theory with goal setting theory will therefore provide environments that promote autonomous motivation for behavior change and a framework for planning and implementing behavior change. This will have the effect of the selected goals being consistent with psychological needs, fostering greater autonomous motivation, and increasing the likelihood that individuals will self-regulate rather than be regulated by external

contingencies, which would be the case were their goals thwarting or incongruent with psychological needs. To accomplish these outcomes, the current intervention will encourage participants to set specific and difficult weekly goals in the context of goal attainment related to health outcomes motivated by enjoyment.

Study aims

As the study focuses on changes in key behaviors relating to energy balance and weight loss, there are two primary outcome variables of the trial: changes in adolescent physical activity and food intake (see Straker, et al., 2012, p. 6). We aim to test the mechanisms that underpin the action of the trial on these outcomes using two models that incorporate key mediators of the trial effects on the outcomes. The first model includes outcomes associated with need-supportive environments provided by parents and instructors and includes the following hypotheses (see Fig. 1). Adolescents' perceived need-support provided by parents will predict greater self-determined behavior (H1), which will predict greater engagement in physical activity and healthy eating behaviors (H2). Adolescents' and parents' perceptions of instructors' need-support will have a positive effect on adolescents' autonomous motivation to engage in physical activity and healthy eating behaviors and parents' autonomous motivation to perform behaviors to support these choices (H3), which will positively predict adolescents' healthy lifestyle behaviors (H4). The second model refers to outcomes associated with goal setting techniques promoted by instructors and are hypothesized as follows (see Fig. 2). Adolescents' and parents' exposure to intervention environments supporting autonomous and intrinsic goal setting will predict greater goal attainment for adolescents' physical activity and healthy eating behavior goals and parents' behavior goals to support their adolescents' choices (H5), which will predict an increase in adolescents' involvement in healthy lifestyle behaviors (H6).

Methods

Study Design

The intervention will be delivered using a waitlist controlled, staggered cohort entry design comprised of three waves. Two cohorts will start in the first two waves and three cohorts will start in the third wave, totaling 7 cohorts. Participants will be waitlisted for one school term (three months) and then asked to complete follow-up assessments at 3, 6, and 12 months post-intervention (see trial flow chart, Straker, et al., 2012, p.7). This design was chosen as a randomized controlled trial was not possible given the difficulty in providing a plausible placebo intervention considering community knowledge of interventions for being overweight, the likely drop-out of a significant proportion of participants allocated to a non-active control group , and the investigators' belief that it was unethical to withhold a valid intervention for adolescents in clear need. The waitlist control period enables a comparison of changes without intervention, akin to a control group, and the staggered entry controls for the effect of external events and thus would not have a systematic effect on the analysis.

Participants

Our power analysis was calculated based on a path analysis based regression models with non-latent, manifest variables and proposed a medium effect size ($f^2 = .15$) of two predictor variables (independent variable and mediator) on the dependent variable consistent with the effect sizes reported in previous meta-analysis in the self-determination theory literature (Ng et al., 2012). Assuming 80% power at a 5% level of significance, a sample size of 70 is needed at one year follow-up. Based on 33% attrition in our pilot study (K. L. Smith et al., 2011) and 13% attrition reported in longitudinal interventions in obese populations (Mathieu, Philippe, & David, 2013; Silva et al., 2010), attrition at one year follow-up was assumed to be 20% for the current study. Allowing for 20% attrition, 88 participants will be required at entry.

Cohorts of 12-15 participants will be recruited through the health system, education facilities, and mass media messages in the general community. Volunteers will be eligible to participate if they are between 11 to 16 years of age, have a body mass index greater than the 85th percentile, passed screening conducted by a medical practitioner, are willing to attend twice weekly sessions (during 8 week intensive program) and follow-up assessments (during 1 year post-intervention), and are not currently receiving treatment for a psychological disorder, or obese due to a medical disease or genetic reasons.

Protocol

The intervention will be delivered in local community settings over an eight-week period by a multidisciplinary allied health team including physiotherapists, dieticians, and psychologists. Each session will include a 45 minute exercise class for adolescents and a one hour joint education session with parents that is focused on healthy eating, physical activity, and goal setting strategies. During adolescents' physical activity sessions, parent-only sessions will address adolescent development, providing environments comprised of need-supportive behaviours, and practical skills for supporting adolescents' healthy lifestyle behaviour changes (e.g., reading food labels). The current protocol details how the multidisciplinary components described elsewhere (Straker, et al., 2012, p. 6) will be delivered by instructors in the context of need-support and goal setting by using a process of mapping behavior-change techniques on to the associated change outcomes in order to achieve study aims (see Table 1). We begin by presenting the relationship between each behavior-change technique and the associated change mediators and subsequent change outcomes. Components and implementation methods developed based on these processes are then described at a level of detail to allow for effective evaluation and replication.

Behavior Change Intervention

Instructor training.

Prior to the intensive program implementation, instructors will receive two and a half hours of training in a group format lead by the primary author. The initial half hour will cover program rationale and structure, followed by two hours devoted to training in behavior-change techniques. The first half hour of training in techniques will focus on need-supportive behaviors, followed by one hour devoted to goal setting methods, with the last half hour dedicated to answering questions and discussing logistics of program delivery.

Autonomy support, structure, and involvement.

Training instructors in behavior-change techniques will be presented as serving a dual-purpose by providing instructors with the skills and stylistic elements to firstly deliver the program content using need-supportive behaviors and secondly to provide parents with the knowledge and skills to support and complement the instructors' need-supportive delivery of content to foster a need-supportive relationship with adolescents. Concepts will be described as applying to all individuals, with specific examples focused on instructor/participant interactions. Instructors will combine their understanding of these learning processes with the highly structured intervention program content to form their training on how to assist parents in adopting and utilizing need-supportive behaviors.

Training will open with a rationale for using behavior-change techniques by detailing the relationship between these techniques and change outcomes. Need-supportive behaviors will then be introduced as a means for achieving change outcomes by increasing adolescents' intrinsic motivation to perform healthy lifestyle behaviors and parents' intrinsic motivation for behaviors to support adolescents' changes. Behaviors required to provide need-supportive environments will be described as shown in Table 2 (Edmunds, Ntoumanis, & Duda, 2007).

Rationale and examples of how behavior-change techniques might appear in the intervention will also be provided for each sub-behavior comprising autonomy support, structure, and involvement. For instance, to make participants feel they belong and are important, instructors will be encouraged to talk 'with' participants by redistributing classroom dynamics to sit at participants' level and/or by standing in the middle amongst participants instead of lecturing in the front of the room.

Participant needs will then be described and parallels drawn between instructor behaviors and the needs they directly support to help illustrate how behavior-change techniques map on to change mediators (see Table 2). Subsequent examples will be provided to clarify what each need might look like and to illustrate possible outcomes for both adolescent and parent participants. For instance "feeling they can choose for themselves" will be described as: "adolescents choose to play soccer because they enjoy it, not because their parents tell them to play; and parents choose walk with their adolescents because they value their adolescents' health".

Concepts will be further highlighted through discussions of instructor-generated examples of need-satisfaction behaviors and participant needs. In addition, instructors will be asked to observe a role play and discuss instances when need satisfaction and behaviors to support these needs are demonstrated. Instructors will also be asked to demonstrate behaviors in pairs to ensure they understand participants' experiences of need satisfaction and the instruction style required for leading intervention sessions. Feedback on instructors' demonstration of need-supportive behaviors will be provided with additional suggestions given as necessary. The training session will conclude with distribution of take-home materials covering descriptions and examples of instructor behaviors and participant needs, as well as empirical evidence addressing the relationship between need-supportive behaviors and maintenance of behavior changes.

Goal setting.

Goal setting will be introduced as a strategy for assisting participants to implement and maintain intrinsically-motivated behaviors. Types of goals participants are asked to set will first be described, followed by rationale for each goal type and methods for taking participants through goal setting processes. Weekly subgoals will be described as a means for making the task seem more manageable; specific goals as enabling frequent assessment of progress; and difficult goals as enhancing concentration and persistence. Setting goals in the context of intrinsic and autonomous goal strivings will be explained as a method for enhancing intrinsic motivation, which is more likely to lead to goal attainment.

Instructors will be asked to convey similar rationale to participants, along with taking participants through goal setting sheets that provide a step by step format for setting goals based on methods from goal setting theory and self-determination theory (described further in adolescent and parent goal setting sections). Instructions on how to guide participants through the sheets will be provided followed by a role play demonstrating behaviors and the opportunity to practice behaviors. Take-home materials will include scripted program content to deliver goal setting sessions and empirical evidence supporting goal setting strategies. Instructions included during training and within the program content will emphasize the importance of phrasing all intervention components to encourage goal strivings related to health outcomes and participant enjoyment.

Booster sessions.

Following rater-assessed sessions (e.g., twice per wave), instructors will be provided with feedback on their delivery of need-supportive behaviors and communication encouraging the setting of intrinsic and autonomous goals. Feedback will be specific to each instructor's unique provision of need-supportive behaviors, highlighting specific strengths and areas for improvement (Tessier, Sarrazin, & Ntoumanis, 2008).

Program components

Parent training – autonomy support, structure, involvement.

Training will be delivered to parents in a single program session, totaling 50 minutes. Two 15-minute segments will be dedicated to content addressing adolescent needs and parent behaviors to support these needs. The session will conclude with 20 minutes allocated for parents' reflection on their understanding of need-supportive concepts. Parent need-supportive behaviors will be introduced as a means to foster adolescents' motivation to engage in behaviors to improve their health and physical fitness. Adolescent needs will then be mapped on to each behavior to explain the relationship between parent behavior-change techniques and adolescent outcomes. Adolescent needs and parent need-supportive behaviors will be described in line with content delivered in the instructor training, with slight modifications made to reflect instances unique to adolescent/parent relationships (e.g., providing structure by 'modeling positive behavior to your adolescent by setting and following through with your goals').

Examples of needs and need-supportive behaviors will be provided, for instance: give adolescent options for being active with parent (autonomy support); ensure fruit is available (structure); and spend time each day talking about adolescent's day (involvement). An instructor will then illustrate concepts in a scripted role play with a parent volunteer, while remaining parents work as a group to generate examples of instances in the role play when support behaviors are demonstrated and how needs map on to these behaviors. Responses will be discussed and instructor feedback provided highlighting appropriate responses and offering corrections when needed. Parent reflection concluding the session will allow parents to discuss concepts learned to ensure they feel comfortable applying behaviors in the home environment. Material outlining concepts and examples of needs and behaviors comprising autonomy support, structure, and involvement will be provided.

Methods for delivering behaviors in the home environment will also be reinforced through program content each week. For instance, autonomy support will be described in the session for overcoming barriers (e.g., exploring behavior options); structure will be explained as the basis for the topic of meal planning and setting house rules; and parenting styles will be described along a continuum ranging in the degree of structure and involvement provided. In each instance particular attention will be afforded to address parents' management of the commonly used method of rewards. Behavior options, for example, will include reviewing pros and cons of rewards and need-supportive alternatives, and descriptions of behaviors associated with parenting styles will explore the role of rewards. In particular, we will encourage parents to arrive at means to use rewards as incidental to behavior change rather than its focus, consistent with self-determination theory that suggests that rewards can have an informational rather than a controlling function (Hagger et al., 2013). Each week, parents will also have the opportunity to discuss experiences related to implementing the behaviors.

Adolescent goal setting.

Adolescents will set goals to achieve by the end of the program based on a matrix of their reported current physical activity and healthy eating behaviors. Adolescents will be given guidance on how to use goal-setting techniques to break their overall goals into weekly subgoals to enhance their goal attainment. The rationale described in the instructor training will be provided for goal types and an example of how to set goals will be included in relation to strivings for physical activity, healthy eating, and sedentary behavior. Examples will take participants through the following goal-setting strategies and prompt them to record the characteristics of the goals (see Table 3): challenge ratings (0-10 score to ensure goal difficulty), goal contents (e.g., "What do you want to happen by achieving your goal?"), goal regulations (e.g., "Why is it important you achieve this goal?"), and specific details outlining what they will do each day to achieve their weekly goal (e.g., Monday: Walk 1km at 5.30

p.m.). Adolescents will then complete their own weekly goals using these strategies alongside instructor collaboration. Instructors will also remind adolescents each week to consider setting goals related to health outcomes motivated by enjoyment based on the premise that such goals are more likely to increase goal attainment and sustained behavior change. Each week, once goals are set with instructors, adolescents and parents will be guided through a sharing process to enable parents to work collaboratively with adolescents to set goals for their own behaviors to support adolescents' goal choices.

Parent goal setting.

Goal-setting content delivered to adolescents will be modified to reflect setting goals for behaviors where parental involvement is paramount for adolescents' to achieve their goals. Parents will learn how to set support goals using the same goal setting strategies introduced to adolescents (see Table 3). Examples and group discussions regarding methods for parent goal setting will then be used to clarify how the mapping process might look in goal setting discussions with their adolescent. Parents will be provided a sheet of tips to help incorporate autonomy support, structure, and involvement behaviors when discussing and setting goals to support their adolescent. Encouragement will also be provided for parents to remind adolescents to maintain self-determined reasons for goal setting in the context of setting difficult and specific goals. Each week, parents will review their goal progress with instructors and then partake in discussions with adolescents to set support goals.

Outcome measures

Primary and secondary outcomes will be assessed using a seven day accelerometer measure, a 3-day food record, and self-report measures of motivation, perceived support, and goal attainment (see Straker, et al., 2012, p.6; p.8). Participants will be monitored for changes in psychological well-being across assessments (see Straker, et al., 2012, p.8).

Process evaluation

Manipulation checks of instructors' delivery of behaviors (e.g., autonomy-support, structure, and involvement; goal setting theory techniques; and promotion of intrinsic and autonomous goal setting) will be assessed using rater observations, instructor self-report, and perceptions of instructor support reported by adolescents and parents. Following each program wave, focus groups will be conducted with facilitators to gain an understanding of barriers and facilitators regarding implementation of integrated goal setting techniques and parent training in need-supportive behaviors. Program attendance will be recorded at each session, and participants excluded from analysis related to primary outcomes in instances when parents are absent from content introducing need-supportive behaviors.

Analyses

Data will be analyzed using a partial least squares path analysis and the SmartPLS 2.0 statistical software (Ringle, Wende, & Will, 2006). Partial least squares (PLS) path analysis is a distribution-free analytic method and enables researchers to test a network of relationships from a theoretical model simultaneously when the variables involved are likely to have departures from normality or small sample sizes as is the likely case in the current trial. This analytic technique has been successfully used by members of the current research team to test integrated theoretical models in the health domain (Chan & Hagger, 2012a, 2012b). The proposed models for parent and adolescent participants will be tested using simultaneous process and the fit of the proposed model to the data evaluated. Models will be tested using residualized change scores computed using baseline and follow-up measures of the psychological and behavioral variables. This approach has also been applied in previous research testing integrated theoretical models using path analysis and a pre-post intervention design (Jacobs, Hagger, Streukens, De Bourdeaudhuij, & Claes, 2011).

Ethics

This study protocol was approved by Curtin University Human Research Ethics Committee (HR105/2011). Study risk and benefits will be addressed and consent obtained prior to entry assessments.

Discussion

Adolescent obesity has been identified as a significant public health issue due to the accompanying health-related problems likely to remain into adulthood. Current rates of adolescent obesity indicate an urgent need to develop effective interventions that promote long-term engagement in physical activity and healthy eating behaviors shown to reduce adolescents' levels of overweight and obesity. The previous evidence base suggests it is important to develop interventions grounded in theory to maximize the likelihood of sustained behavior change. These studies have been successful in showing benefits of independently applying self-determination theory and goal setting theory in relation to adolescents' healthy lifestyle behaviors. However, studies have yet to explore the joint application of these theories, and in particular, how these theories can best be applied in a family-based lifestyle behavior program.

The current study was designed to resolve these shortcomings by allowing for the effective evaluation of motivational behavior-change techniques based on the integration of self-determination theory and goal setting theory in a family-based lifestyle intervention. The aim of the study is to enhance self-determined motivation and subsequent engagement in physical activity and healthy eating in adolescents, and parent behaviors to support these changes. To accomplish these aims, the current study will be the first to explore behavior-change techniques used in training instructors and parents how to deliver autonomy support, structure, and involvement behaviors alongside a goal setting framework that encourages implementation of self-determined behaviors.

Despite these strengths, potential limitations of the current design are worth noting. The intervention will be delivered over 16 sessions during which barriers to attendance may present (Williams et al., 2010). Although training in need-supportive behaviors and goal setting methods will be reinforced throughout all program content, these concepts will primarily be introduced across two sessions. Participants unable to attend the respective sessions may subsequently lack understanding of these motivational components. This potential limitation is likely resolved by program instructors emphasizing the importance of attendance at each session to inform learning of future concepts within the intervention.

Implications

Detailed reporting of techniques used in the current study will inform future interventions by allowing for the replication of effective methods for teaching behavior-change techniques to promote maintenance of adolescent physical activity and healthy eating behaviors. Best practice methods informed by findings from the current study may be instrumental in contributing to a reduction in the prevalence of overweight and obesity in Australia and worldwide.

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Table 1

Relationship among behaviour-change techniques, change mediators, and change outcomes.

Behaviour change technique *(need-supportive environment)*	Change mediator	Change outcome
Significant other [a] provides:	Self-determined behaviour:	*Adolescents*: Adherence to physical activity and healthy eating behaviours *Parents*: Adherence to behaviours that support adolescents' physical activity and healthy eating behaviours
• Autonomy support • Structure • Involvement	Feeling a sense of choice *(autonomy)* Feeling competent in abilities *(competence)* Feeling a sense of belonging *(relatedness)*	
Significant other [a] encourages:	Self-determined goal attainment:	
• Intrinsic goal content • Autonomous goal striving	Achieving goals related to health reasons Achieving goals related to interest/enjoyment	

[a] Includes instructors (change objective: adolescents and parents) and parents (change objective: adolescents)

Table 2

Description of behaviors, delivery mode, and the needs supported by behaviors.

Behavior type description	Methods for behavior delivery	Need-support description	Experience of need support
Supporting choices. *(autonomy support)*	Offer several options for behavior change using neutral language like "may" and "could" (instead of "should" or "must"). Offer verbal praise for attempts at behavior change. Respond positively to participants' issues. Provide meaningful rationale for behaviors.	Feeling they can choose for themselves. (*autonomy*)	Feel they made their own choices to live by instead of someone else choosing for them or only doing behaviors to please others.
Providing structure. *(structure)*	Demonstrate leadership by modeling positive behavior through demonstrations of goal setting and behavior-change techniques. Give direct feedback to questions. Provide tasks that are challenging but "do-able".	Feeling competent in their abilities. (*competence*)	Feel like they can actually do the things they want to do, or tasks required by others
Being involved. *(involvement)*	Try to understand participants' motivations for behaviors. Talk with participants instead of at them. Show an interest in participants' well-being and progress in their behavior changes.	Having a sense of belonging. (*relatedness*)	Feel like they have support without any external reinforcement like rewards from others.

Table 3

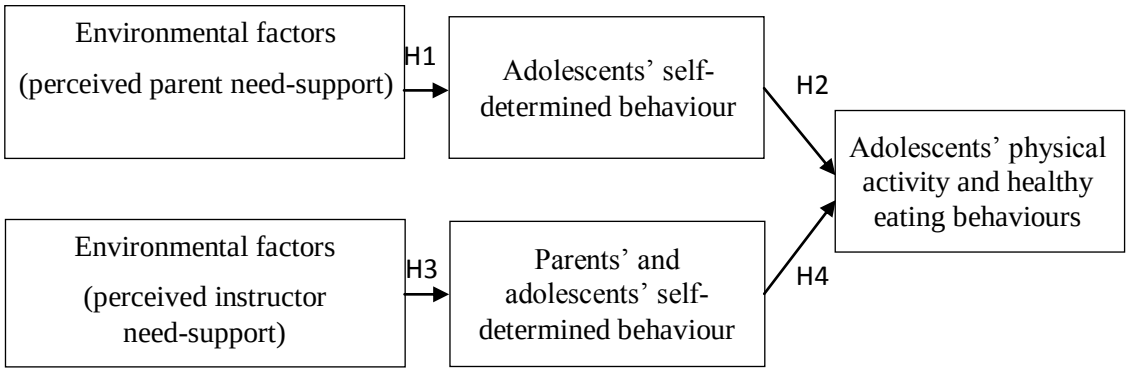
Description of goal setting techniques, underlying theory, and practical strategies.

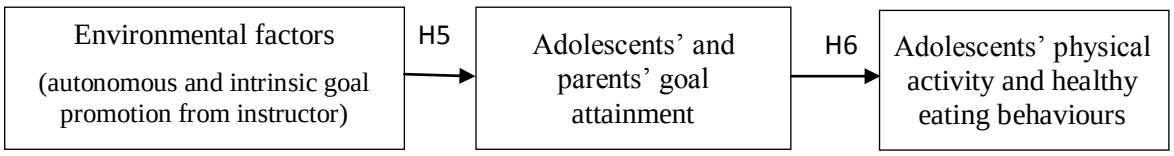
Teen goal steps	Teen example	Parent goal steps	Parent example
Set program goals for physical activity and healthy eating based on current behaviors *(distal)*	**Overall program goal:** To be moderately active 30 minutes 4-5 times a week.	Discuss with teen and record a copy of their physical activity and healthy eating goals *(distal)*	**Overall program goal:** Support my teen's goal to be moderately active 30 mins 4-5 times a week.
Set weekly goals for physical activity and healthy eating, including perceived challenge *(proximal and difficult)*	**My goal this week is to:** Be moderately active for 15 minutes 4 times/ week. (Challenge: 7)	Discuss with teen, and set weekly goals for supporting their physical activity and healthy eating goals, including perceived challenge *(proximal and difficult)*	**My goal this week is to support my teen's goal to:** Be moderately active for 15 minutes 4 times/ week. (Challenge: 7)
Record reasons: "what you want to happen" and "why it is important" *(intrinsic and autonomous)*	**What:** To be more physically active. **Why:** I enjoy being active with friends.	Record reasons: "what you want to happen" and "why it is important" *(intrinsic and autonomous)*	**What:** My teen to be more physically active. **Why:** I enjoy being active with my teen and seeing him/her be active with friends.
Record daily behaviors to achieve *(specific)*	**Mon/Th:** CAFAP physical activity session **Tue:** Walk to/from school **Wed:** Zumba with mom 6.30 p.m. to 7.00 p.m. **Sat:** Walk one mile at park and bike ride 30 mins with friend	Record daily behaviors to achieve *(specific)*	**Mon/Th:** Bring to CAFAP **Tue:** Allow teen to walk to/from school (e.g., try not to provide car ride) **Wed:** Zumba together 6.30 p.m. to 7.00 p.m. **Sat:** Family walk one mile at park and allow teen to ride bike 30 mins with friend

Figure Captions

Figure 1. Model describing predicted relationships among instructor and parent behaviour change techniques, adolescent and parent motivation, and adolescent behaviour outcomes.

Figure 2. Model describing predicted relationship among instructor behaviour change techniques, adolescent and parent goal attainment, and adolescent behaviour outcomes.


Environmental factors
(perceived parent need-support)
H1
Adolescents' self-determined behaviour
H2
Adolescents' physical activity and healthy eating behaviours
Environmental factors
(perceived instructor need-support)
H3
Parents' and adolescents' self-determined behaviour
H4


Environmental factors
(autonomous and intrinsic goal promotion from instructor)
H5
Adolescents' and parents' goal attainment
H6
Adolescents' physical activity and healthy eating behaviours