

Exploration of the Mechanisms of Change in Constructs From Self-Determination Theory and Quality of Life During a Multidisciplinary Family-Based Intervention for Overweight Adolescents

Ashley A. Fenner, Erin K. Howie, Leon M. Straker, and Martin S. Hagger
Curtin University

The current study explored whether a multidisciplinary family-based intervention underpinned by self-determination theory could enhance perceptions of parent need support, autonomous motivation, and quality of life in overweight and obese adolescents. Using a staggered-entry waitlist-period control design, adolescents ($n = 56$) were assessed at baseline and preintervention (within-participant control), immediately following intervention, and at 3, 6, and 12 month follow-ups. Parents were trained in need-supportive behaviors within the broader context of an 8-week multidisciplinary intervention attended jointly with adolescents. Following intervention, significant improvements were demonstrated in adolescent perceptions of parent need support, autonomous motivation, and quality of life, and changes were maintained at the 1-year follow-up. Mediation analyses revealed changes in perceptions of parent need support predicted changes in quality of life indirectly via changes in autonomous motivation. Findings suggest overweight and obese adolescents are likely to benefit from multidisciplinary family-based interventions that aim to train parents in need-supportive behaviors.

Keywords: adolescent, obese, self-determination theory, parent training, quality of life

Given evidence of high rates of obesity in adolescents (Olds et al., 2011) and the associated maladaptive psychosocial and physical outcomes (Pulgarón, 2013), adolescence has been identified as a critical period for behavioral interventions to manage obesity (Hirvensalo & Lintunen, 2011). Reviews of the literature suggest that interventions targeting adolescent obesity are most likely to be effective if placed within a multidisciplinary family-based healthy lifestyle context (Oude Luttikhuis et al., 2009). To ensure efficacy and replication researchers have also advocated for understanding theory-based mediators proposed to influence change associated with intervention (Michie & Prestwich, 2010).

One theory that has been shown to be effective in explaining variance in psychosocial and physical outcomes in the context of environmental supports is self-determination theory (Deci & Ryan, 2000). According to the theory, individuals have three basic, innate needs: autonomy, competence, and relatedness. The extent to

which one's environment is able to satisfy these needs, through the provision of autonomy support, structure, and involvement, is posited to predict the degree to which a behavior is performed for more autonomous (e.g., self-determined) rather than controlled reasons (Chatzisarantis, Hagger, & Smith, 2007). Environmental supports are therefore proposed to predict psychosocial and physical outcomes via an individual's degree of autonomous motivation (Ryan, Patrick, Deci, & Williams, 2008).

Even though a growing body of evidence supports the utility of autonomous motivation in predicting psychosocial and behavioral outcomes (Williams, Teixeira, Carraça, & Resnicow, 2011), as well as perceptions of need support in predicting autonomous motivation (Chatzisarantis & Hagger, 2009), only a handful of studies have explored the mediation pathway proposed in self-determination theory in relation to health promotion interventions for adolescents (Ng et al., 2012). These studies have been successful in demonstrating support for the indirect relationship from perceptions of need support to behavioral and psychosocial outcomes via autonomous motivation. However, environmental manipulation of need support has been primarily conducted in physical education contexts (Standage, Gillison, & Treasure, 2007) despite the role of parents in predicting proposed pathways in self-determination theory (Sallis, Prochaska, & Taylor, 2000; Wild & Enzle, 2002) and the equivalent

Ashley A. Fenner and Martin S. Hagger are with the School of Psychology and Speech Pathology, Curtin University, Perth, WA, Australia. Erin K. Howie and Leon M. Straker are with the School of Physiotherapy and Exercise Science, Curtin University, Perth, WA, Australia. Address author correspondence to Ashley A. Fenner at ashley.fenner@postgrad.curtin.edu.au.

benefits of considering healthy eating contexts (Buttitta, Iliescu, Rousseau, & Guerrien, 2014).

In the few family-based healthy lifestyle interventions conducted, training parents in need-supportive behaviors has been shown to lead to reductions in sedentary behavior in children (Jago et al., 2013) and adolescents (St. George, Wilson, Schneider, & Alia, 2013). Studies in domains other than health have found that training parents in need-supportive behaviors is associated with enhanced academic outcomes, improvements in well-being, and reductions in externalizing and internalizing symptoms (Froiland, 2011; Joussemet, Mageau, & Koestner, 2014). However, no study to date has measured the effects of family-based lifestyle interventions targeting parent need support on adolescent perceptions of parent need support, autonomous motivation, and quality of life outcomes.

A further limitation of previous studies is that few have adequately accounted for temporal changes in motivational constructs. Better approaches that account for changes in these factors are likely to have greater value when it comes to understanding how behavior changes over time. A few studies adopting cross-lagged panel designs to predict change and control for the stability of motivational constructs over time have been conducted in the context of social cognitive models of health behavior (Hagger, Chatzisarantis, Biddle, & Orbell, 2001; Jacobs, Hagger, Streukens, De Bourdeaudhuij, & Claes, 2011; Liska, Felson, Chamlin, & Baccaglioni, 1984). However, there has been no research examining the effect of dynamic changes in self-determination theory process variables (i.e., parent need support and adolescent motivation) within the context of healthy lifestyle interventions. A major innovation of the current study is the examination of change in the quality of life and motivational variables over time, an approach that is in contrast to the typically “static” perspective adopted in many studies testing psychological theories and models in health contexts.

In line with the predictions of self-determination theory, the current study explored changes in theory-based variables (perceptions of parent need support and autonomous motivation) proposed to mediate quality of life outcomes following involvement in an intervention for overweight and obese adolescents and their parents, Curtin University’s Activity, Food, and Attitudes Program (CAFAP). This is consistent with process models of motivation and outcomes in health contexts based on self-determination theory, such as the model proposed by Williams et al. (2006). The model depicts the dynamic process by which changes in need support leads to changes in adaptive health outcomes mediated by changes in autonomous motivation. The protocol, theoretical underpinnings, and effect on physical activity and healthy eating behaviors and mental health are reported elsewhere (Fenner, Howie, Davis, & Straker, 2016; Fenner, Straker, Davis, & Hagger, 2013; Straker et al., 2012, 2014).

In accordance with the theoretical framework of self-determination theory (Deci & Ryan, 2000), we hypothesized that: (1) Adolescent quality of life (and

perceptions of parent need support and autonomous motivation in relation to physical activity and healthy eating) would be greater during the postintervention, 3-, 6-, and 12-month follow-up assessments in comparison with the preintervention assessment; (2) The rate of change in adolescent quality of life (and perceptions of parent need support and autonomous motivation in relation to physical activity and healthy eating) would be greater during the intervention and maintenance periods compared with the waitlist period; (3) Across all assessment points changes in adolescent quality of life would be related to changes in perceptions of parent need support; and (4) Predicted changes in quality of life would be mediated by changes in adolescent autonomous motivation in relation to both physical activity and healthy eating.

Methods

Study Design

CAFAP was implemented in community settings using a waitlist-period controlled staggered cohort-entry design, which reduces error variance associated with individual differences and increases power to accommodate expected high drop-out rates (Oude Luttikhuis et al., 2009). This design was chosen to adhere with recent evidence suggesting the need for alternative research designs that seek to minimize ethical concerns associated with withholding intervention to groups in need, while allowing for assessment of maintenance of changes (Peinemann, Tushabe, & Kleijnen, 2013).

Participants completed baseline assessments, then waitlisted for one school term (3 months) before completing preintervention assessments to provide a within-participant control. Assessments were then conducted immediately following the intensive intervention and at 3-, 6-, and 12-months follow-up. The intensive 8-week (two hour biweekly sessions) intervention was delivered by multidisciplinary teams of instructors (e.g., physiotherapists/exercise physiologists, dieticians, and psychologists) across three locations in Western Australia with a high proportion of low socioeconomic status residents. Program entry was staggered across three cohorts (February, May, August 2012) to control for seasonal variations and external bias. The study is registered with the Australia and New Zealand Clinical Trials Registry (No. 12611001187932), and was approved by Curtin University’s Human Research Ethics Committee (HR105/2011). A detailed description of the study design can be found in the published protocol (see Straker et al., 2012).

Participants

Families were included in the study if adolescents were between 11–16 years of age, had a BMI greater than the 85th percentile with respect to their age and sex, passed a medical screening conducted by a general practitioner, were willing to attend intervention sessions and pre- and postprogram assessments alongside the household parent

predominately responsible for supporting lifelong physical activity and eating habits, and were not undergoing treatment for a psychological disorder or obese due to a medical condition. Following recruitment targeted primarily in low socioeconomic areas surrounding program locations (e.g., health professionals, local schools, community newspapers, flyers), 123 potential families expressed interest in the study and 69 adolescents/parent pairs provided informed consent and enrolled in the study. Flow of participants is described in more detail elsewhere (Straker et al., 2015).

Intervention

During the first hour of all program sessions adolescents engaged in physical activity routines guided by the physiotherapist/exercise physiologist while parents received educational information. Adolescents and parents jointly explored educational concepts in the second hour. Before program delivery, facilitators were trained to provide need-supportive environments to promote autonomous motivation for behavior change in adolescents and parents (to support adolescents). Facilitators also guided parents in methods for delivering need-supportive behaviors to promote adolescent engagement in healthy lifestyle behaviors. Parent training was conducted in accordance with previous evidence-based guidelines (Cheon, Reeve, & Moon, 2012) during the parent-only hour of the second intervention session. Behavior-change techniques inclusive of autonomy support, structure, and involvement were equally targeted with definitions and examples provided alongside role modeling opportunities. Mediators of changes in outcomes due to intervention (feeling a sense of autonomy, competence, and relatedness) were also detailed alongside examples of key outcome variables expected to change (i.e., adolescents' autonomous motivation, adherence to healthy lifestyle behaviors, and well-being).

Parents' knowledge and capabilities for practical skills to use in implementing need-supportive behaviors was enhanced during remaining parent-only sessions focused on topics such as expectations, recipe modification, overcoming barriers, parenting styles (described on continuum ranging in the degree of structure and involvement), and "walk and talk" discussions that encouraged reflection on experiences among parents and facilitators. Joint sessions facilitated a space where parents were encouraged to practice need-supportive behaviors (i.e., goal setting, involvement in creating artwork together as a means of reflecting on shared experiences, and exploring methods for community engagement to enhance relatedness in external settings) and gain further practical skills through topics such as label reading, portion sizes, and problem solving healthy snacks.

Goal setting content was integrated with self-determination theory to provide a motivating structure for implementing behavior change by asking adolescents and parents to set distal and proximal goals that were specific, difficult, and intrinsic in content and autonomously motivated. Parent goals mapped directly onto adolescent goals to ensure adolescents had choice in their goals and

parents could provide home environments to enhance competence in goal-related areas as well as support relatedness through involvement in goal setting processes. Further details of the theoretical underpinnings, protocol for training parents in need-supportive behaviors, and program content has been published elsewhere (Fenner, Straker, Davis, & Hagger, 2013; Straker et al., 2014).

Measures

Perceptions of Parent Need Support. The Perceived Autonomy Support Scales for Exercise Settings (PASSES; Hagger et al., 2007) and the Perceived Environmental Supportiveness Scale (PESS; Markland & Tobin, 2004a) were modified to measure adolescent perceptions of parent need support in relation to physical activity and healthy eating. Responses were indicated using seven-point scales ranging from 1 (*strongly disagree*) to 7 (*strongly agree*), and summed to create a mean score for physical activity and healthy eating, respectively.

Autonomous Motivation. Adolescent autonomous motivation for physical activity was measured using a modified version of the revised Behavioral Regulation in Exercise Questionnaire Version 2 (BREQ-2; Markland & Tobin, 2004b) and the Integrated Regulation Scale for Exercise Behavior (McLachlan, Spray, & Hagger, 2011). Adolescent autonomous motivation for healthy eating behaviors was measured using an adapted version of Ryan and Connell's (1989) Perceived Locus of Causality for Diet (PLOC; Hagger, Chatzisarantis, & Harris, 2006) and the Integrated Regulation Scale for Exercise Behavior (McLachlan et al., 2011). Adolescents indicated their feelings about participating in physical activity and healthy eating behaviors using a four-point scale ranging from 1 (*not at all true*) to 4 (*very true*). Mean scores for each type of motivation were assigned the following weights and summed to form a single relative autonomy index (RAI) for physical activity and healthy eating, respectively: intrinsic +3; integrated +2; identified +1; introjected -1; external -2; amotivation -3.

Quality of Life. Adolescent quality of life was measured using the Pediatric Quality of Life-Teen Report (PedsQL; Varni, Seid, & Kurtin, 2001). The inventory comprises generic core scales measuring physical, emotional, social, and school functioning, with the total, physical, and psychosocial health summary scores having acceptable validity and reliability. A five-point scale was used ranging from 0 (*never a problem*) to 4 (*almost always a problem*), and values reverse-scored and linearly transformed to a zero to 100 scale (0 = 100, 1 = 75, 2 = 50, 3 = 25, 4 = 0), such that higher scores reflected better quality of life.

Statistical Analyses

Only participants with at least two assessments were included in statistical models ($n = 56$). Missing values were accounted for using likelihood-based estimation,

which uses all available information to produce final estimates. Data were inspected for potential outliers and data entry errors. Two outliers were identified (i.e., >3 *SD* from the mean) during follow-up periods for adolescent perceptions of parent need support. These outliers remained in the data set due to a lack of influence on significant differences in outcomes. Normality of distribution was assessed using histograms, boxplots, and values of skewness and kurtosis. Standard errors were bootstrapped for all analyses with 1,000 replications to adjust for non-normally distributed variables (Preacher & Hayes, 2004). Descriptive statistics were calculated at baseline for participants who completed the intervention and maintenance periods, as well as for participants who dropped out either during the waitlist or maintenance period. Comparisons were made between the three groups using ANOVA and chi-square analyses.

Our four hypotheses were tested by conducting the following analyses:

1. To test changes in adolescent quality of life (and perceptions of parent need support and autonomous motivation for physical activity and healthy eating) at postintervention, 3-, 6-, and 12-months follow-up in comparison with preintervention values, separate generalized linear mixed models were used (McCulloch & Neuhaus, 2001) with a priori linear contrasts to compare differences in mean point estimates at each time point to those at preintervention. As measures were repeated within participants (six assessments per person), an exchangeable correlation structure and random intercepts for each individual were used to account for the correlation between assessments within individuals. No explicit adjustment was made to control for multiple comparisons, and as such 95% confidence intervals are presented for all parameter estimates along with *p*-values where appropriate.
2. To assess dynamic changes in constructs across the duration of the study, monthly rates of change in adolescent quality of life (as well as perceptions of parent need support and autonomous motivation for physical activity and healthy eating) were calculated

over the following periods to allow for comparison: waitlist (baseline and preintervention), intervention (preintervention to postintervention), and the 12-month maintenance period (postintervention and 12-month follow-up). Calculating monthly rates of change also controlled for the varying amount of time between assessments while allowing the waitlist period to serve as a within-participants comparison.

3. To explore relationships among these self-determination theory constructs and quality of life outcomes, exploratory analyses were conducted using Spearman's correlation.
4. Due to the waitlist control within-participant design, linear mixed multilevel mediation models were used to explore mediation effects of changes in perceived parent need support and changes in autonomous motivation on changes in quality of life. The model assessed the relationship between the variables across all time points, with the multilevel mediation model accounting for the correlation between repeated measures. Multilevel mediation is similar to mediation models using linear regression in which three models are tested (Krull & MacKinnon, 1999). The models are presented in Figures 1 and 2. We first assessed the direct effect of whether changes in perceived parent need support for physical activity predicted changes in quality of life (see Figure 1). Second, we assessed the direct effect of changes in autonomous motivation for physical activity predicting changes in quality of life (path *b*). The indirect effect is the product of the path coefficients $a \times b$. Finally, the mediated path assessed whether changes in perceived parent need support for physical activity (the predictor) predicted changes in quality of life (the outcome) when adjusted for changes in autonomous motivation for physical activity (the mediator) (path c' , Figure 1). The second model (healthy eating) explored the same pathways in relation to healthy eating (see Figure 2). All analyses were performed using Stata/IC v 13.0 (StataCorp LP, College Station TX, USA).

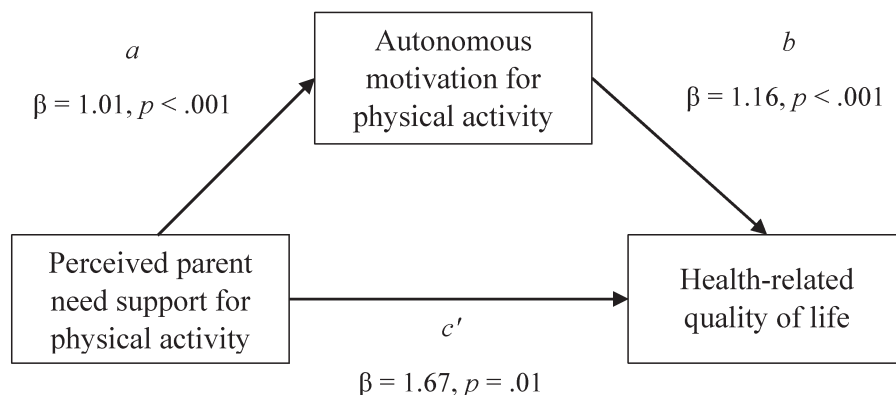


Figure 1 — Physical activity model with unstandardized beta coefficients.

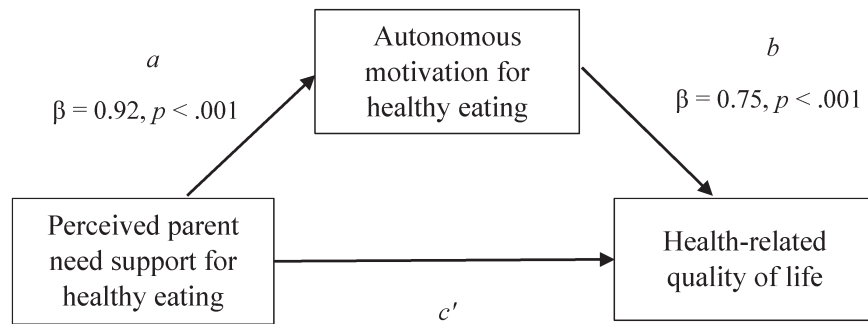


Figure 2 — Healthy eating model with unstandardized beta coefficients.

Results

Baseline Characteristics

Adolescents who remained enrolled in the study for the duration of the 12-month follow-up were no different at baseline to those who dropped out before completing the intervention or during the maintenance phase (all p values > 0.05).

Direct Effects of the Intervention

Perceptions of Parent Need support. Adolescent perceptions of parent need support for physical activity and healthy eating did not change significantly during the waitlist period (between baseline and preintervention), as shown in Table 1. Following the intensive 8-week intervention, a significant increase was demonstrated in point estimates in perceptions of parent need support for physical activity ($M = 5.84$, $SE = 0.12$ compared with $M = 4.83$, $SE = 0.10$, $p < .001$) and healthy eating ($M = 5.99$, $SE = 0.10$ compared with $M = 5.28$, $SE = 0.09$, $p < .001$). Point estimates during the 12-month maintenance period remained significantly elevated from preintervention. In relation to physical activity and healthy eating, the monthly rates of change were significantly different during the intervention period compared with the waitlist period. Monthly rates of change were not significantly different between maintenance and waitlist periods.

Autonomous Motivation. No significant changes were shown in point estimates of adolescent autonomous motivation for physical activity and healthy eating from baseline to preintervention during the waitlist period (see Table 1). Following the intensive 8-week intervention, there were significant improvements in point estimates in adolescent autonomous motivation for physical activity ($M = 6.76$, $SE = 0.47$ compared with $M = 4.96$, $SE = 0.35$, $p < .001$) and healthy eating ($M = 5.68$, $SE = 0.43$ compared with $M = 3.77$, $SE = 0.27$, $p < .001$). Point estimates also remained significantly elevated during the maintenance period compared with preintervention levels. The monthly rate of change in autonomous

motivation for physical activity and healthy eating over the intervention period was also significantly different to the rate of change in each variable during the waitlist period. Monthly rates of change during the maintenance period were not significantly different to rates of change during the waitlist period.

Quality of Life. No significant changes were demonstrated during the waitlist control period. Immediately following intervention point estimates for adolescent quality of life were significantly improved in comparison with levels reported at preintervention ($M = 75.27$, $SE = 1.13$ compared with $M = 70.64$, $SE = 1.06$, $p = .004$), and changes were retained over the 12-month maintenance period. During intervention and maintenance periods, no significant differences were demonstrated in monthly rates of change.

Associations Among Adolescent Variables

Table 2 presents Spearman's correlations among adolescent variables across all assessment points. Results of Spearman's correlations indicate all variables were significantly and positively associated across waitlist, intervention, and maintenance periods.

Mediation Analyses

In the physical activity model, changes in perceptions of parent need support for physical activity had a positive statistically significant total effect on changes in quality of life ($\beta = 2.84$, $p < .001$, 95% CI [1.79, 3.90]). There was also a significant indirect effect of changes in autonomous motivation for physical activity partially mediating this relationship ($\beta = 1.17$, $p < .001$, 95% CI [0.70, 1.65]). In the healthy eating model, changes in perceptions of parent need support for healthy eating had a positive statistically significant total effect on changes in quality of life ($\beta = 2.77$, $p < .001$, 95% CI [1.46, 4.08]). Again, this relationship was mediated by changes in autonomous motivation for healthy eating with a small, but statistically significant indirect effect ($\beta = 0.70$; 95% CI [0.24, 1.15], $p = .003$).

Table 1 Changes in Adolescent Perceived Parent Need support, Autonomous Motivation, and Quality of Life

Variable	Point Estimates, Mean (SE)						Rate of Change, Mean Δ per Month, With 95% CI		
	Baseline	Pre	Post	3 Months	6 Months	12 Months	Waitlist (Baseline to Pre)	Intervention (Pre to Post)	Maintenance (Post to 12 Months)
PPNSPA	5.04 (0.12)	4.83 (0.10)	5.84 (0.12)*	5.61 (0.11)*	5.63 (0.12)*	5.51 (0.14)*	-0.07 [-0.18, .04]	0.51 [0.35, 0.66]*	-0.03 [-0.058, .0025]
PPNSHE	5.48 (0.97)	5.28 (0.09)	5.99 (0.10)*	5.87 (0.10)*	5.75 (0.13)*	5.74 (0.14)*	-0.07 [-0.16, .03]	0.36 [0.22, 0.50]*	-0.021 [-.048, .0068]
AMPA	5.10 (0.34)	4.96 (0.35)	6.76 (0.47)*	7.15 (0.44)*	7.91 (0.50)*	7.42 (0.56)*	-0.05 [-0.43, 0.3]	0.90 [0.35, 1.46]*	0.06 [-0.62, 0.17]
AMHE	4.44 (0.36)	3.77 (0.27)	5.68 (0.43)*	6.07 (0.37)*	5.57 (0.49)*	5.33 (0.52)*	-0.22 [-0.53, .08]	0.96 [0.45, 1.46]*	-0.029 [-0.14, 0.79]
QL	68.42 (1.14)	70.64 (1.06)	75.27 (1.13)*	79.64 (1.59)*	81.04 (1.45)*	76.37 (1.62)*	0.74 [-0.38, 1.86]	2.31 [0.75, 3.88]	0.09 [-0.23, 0.41]

Note. PPNSPA = perceived parent need support for physical activity; PPNSHE = perceived parent need support for healthy eating; AMPA = autonomous motivation for physical activity; AMHE = autonomous motivation for healthy eating; QL = quality of life

*Significant difference from pre point estimate ($p < .05$).

Table 2 Overall Spearman Correlations Among Adolescent Perceived Parent Need support, Autonomous Motivation, and Quality of Life Across All Assessment Periods*

	PPNSPA	PPNSHE	AMPA	AMHE
PPNSHE	.89			
AMPA	.34	.29		
AMHE	.26	.29	.61	
QL	.17	.16	.43	.26

Note. PPNSPA = perceived parent need support for physical activity; PPNSHE = perceived parent need support for healthy eating; AMPA = autonomous motivation for physical activity; AMHE = autonomous motivation for healthy eating; QL = quality of life.

*All correlations significant at the 0.05 level (2-tailed).

Discussion

In the current study, adolescents' perceptions of parent need support in relation to physical activity and healthy eating behaviors were shown to increase immediately following intervention, and these changes remained elevated from preintervention levels at 1-year follow-up. Further, results indicate an intervention aimed at promoting parents' demonstration of need-supportive behaviors was successful at improving adolescents' autonomous motivation for both physical activity and healthy eating behaviors immediately following intervention, with changes from preintervention levels maintained at 1-year follow-up. In addition, the intervention was successful in improving adolescent quality of life from preintervention to 1-year follow-up. Finally, the influence of changes in adolescent perceptions of parental need support on changes in quality of life was partly mediated by changes in autonomous motivation in relation to both physical activity and healthy eating behaviors.

The current study is the first to report changes in overweight and obese adolescents' perceptions of parents' need support and autonomous motivation in relation to both physical activity and healthy eating behaviors following parents' receipt of training in need-supportive behaviors. Furthermore, the research is also unique as it focuses on changes in outcomes over time rather than the "static" predictions often identified in cross-sectional studies (Hagger & Chatzisarantis, 2009). Previous studies in health-promotion contexts aiming to train parents based on the tenants of self-determination theory have also been limited primarily to parents of young children (e.g., Jago et al., 2013), and no studies have explored changes in mechanisms based on tenants of self-determination theory by mediation analysis. Our findings suggest that training parents in need-supportive behaviors can improve adolescents' perceptions of need support for physical activity and healthy eating within the home environment as well as their autonomous motivation to engage in healthy lifestyle behaviors. However,

slight reductions in intensity of changes across the maintenance period suggests that to maintain the full extent of gains made in adolescent outcomes parents may require postintervention support. Booster sessions and follow-up group discussions previously shown to be useful in training physical education teachers (Cheon & Reeve, 2013; Cheon, Reeve, Yu, & Jang, 2014) may prove fruitful during maintenance periods in family-based interventions targeting overweight and obese adolescents.

In support of the proposed intervention models based on self-determination theory, relationships among all proposed variables were also shown to be significantly and positively correlated across the waitlist, intervention, and maintenance periods. These findings corroborate and extend previous findings in physical education settings (Quaresma, Palmeira, Martins, Minderico, & Sardinha, 2014) by demonstrating that in relation to both physical activity and healthy eating, changes in adolescent perceptions of parent need support is associated with changes in adolescent autonomous motivation, and these variables are also directly associated with changes in adolescent quality of life.

Interestingly, although statistically significant changes were demonstrated in adolescent perceptions of parent need support and autonomous motivation for physical activity and healthy eating, the previously reported (see Straker et al., 2014) changes in accelerometer-based physical activity (including sedentary time) and 3-day food diary measures of healthy eating behaviors (e.g., fruit, vegetable, and junk food consumption) following participation in CAFAP were of a modest effect size and not sufficiently substantial to support exploration of mediation pathways. Larger changes in adolescent quality of life in contrast to modest changes in healthy lifestyle behaviors suggests that changes in autonomous motivation (fostered by changes in perceptions of parent need support) may be sufficient for improving adolescent indicators of well-being, but may be insufficient to overcome potential barriers to behavior change in home environments (Edmunds, Ntoumanis, & Duda, 2007). For example, a recent meta-analysis of studies conducted in physical education settings based on self-determination theory, concluded that children and adolescents may be autonomously motivated, but classroom constraints (i.e., instruction, turn taking, transitions between activities) may limit the amount of time available to engage in physical activity (Owen, Smith, Lubans, Ng, & Lonsdale, 2014). Participating parents may have perceived environmental constraints (Eime, Harvey, Craike, Symons, & Payne, 2013). In contrast to indicators of well-being, behavioral outcomes may therefore have been impeded by barriers and access to tangible resources, despite increases in autonomous motivation.

Future studies should consider placing even greater emphasis on potential barriers and problem solving the sourcing of healthy lifestyle methods both during intervention and in follow-up booster sessions. Similarly, it may be of benefit to assess parents' experiences of implementing need-supportive behaviors to better understand potential barriers (i.e., costs and benefits).

Another consideration is that previous studies based on self-reported physical activity have demonstrated a stronger link between autonomous motivation and physical activity than objective measures of behavior (Owen et al., 2014). Mediation was supported in the current study in relation to self-reported quality of life, in contrast to the limited changes in healthy eating behaviors that placed less emphasis on subjective recall (3-day food diaries) and objective measures of physical activity and sedentary behavior. Given the importance of parents' role in adolescents' development of lifelong behaviors, further research is needed using objective measures of physical activity and less subjective measures of healthy eating (i.e., 3-day food diaries) to determine the strength of this relationship following parents' receipt of training. Multiple perspectives from spouses and external observers may also be useful in assessing parent need support. However, one would have to consider potential for the presence of an observer to bias parent behaviors, threat to validity if a spouse was not fully aware of need-supportive behaviors demonstrated, and the absence of spouses in single-parent households.

Strengths and Limitations

Our study has several strengths. To our knowledge, this is the first study to explore self-determination theory-based mediators within the context of an intervention aimed at training parents of overweight and obese adolescents in need-supportive behaviors. The approach of examining change in motivational variables and quality of life outcomes over time is in contrast to the typically "static" perspective most commonly adopted in studies testing motivational theories in health contexts. In addition, theoretically based mechanisms underlying changes were assessed over a 1-year maintenance period following intervention. Assessment of theory-based mediation pathways in the current study suggest that overweight and obese adolescents may benefit from parents' receipt of training in need-supportive behaviors. However, the lack of analyses regarding behavioral and mental health outcomes limits the interpretation of these findings beyond quality of life outcomes.

A potential limitation of the study was use of a within-participants comparison instead of a concurrent control group. However, the ethical issues of withholding a plausible intervention from a population in need for the duration required for long-term follow-up has been noted (Warren, Golley, Collins, Okely, & Jones, 2007), and outcomes from prospective studies suggest limited improvements in autonomous motivation, parenting behaviors, indices of well-being, and healthy lifestyle behaviors in the absence of intervention (Gillison, Standage, & Skevington, 2006; Hagger et al., 2009). Our exclusive focus on autonomous motivation was based on theory (Deci & Ryan, 2000) and evidence (Owen et al., 2014) identifying it as the most important environmental impact on adherence to health behaviors according to self-determination theory (Cheon et al., 2012). Nevertheless, recent attention has been directed toward need-thwarting behaviors, which may be displayed concurrent with

autonomy-supportive behaviors (Costa, Ntoumanis, & Bartholomew, 2015). We look to future research that incorporates measures of need-thwarting behaviors alongside autonomy support to further elucidate the role of controlling interpersonal factors in health-related behavioral interventions.

The limited availability of validated measures to assess adolescent perceptions of parent need support in relation to physical activity and healthy eating meant previous measures were modified for use in the current study. Given the implications on validity, dimensions of need support (autonomy support, structure, and involvement) could not be independently assessed in predicting outcomes in the models presented. Attrition may also have limited study findings. Rates of attrition in the current study are however similar to those demonstrated in family-based interventions with adolescents (Oude Luttikhuis et al., 2009), and sensitivity analyses confirmed results were not influenced by participant dropouts.

Conclusion

Adolescence is a pivotal period for the development of lifelong behaviors and associated affective outcomes (Hirvensalo & Lintunen, 2011), and is a time of transition marked by a balance of support from parents while exploring independence (Laursen & Collins, 2009). As such, it is necessary to explore theory-based variables associated with adolescents' exposure to parents' behaviors that promote more need-supportive home environments. The current study demonstrated that training parents in need-supportive behaviors can enhance adolescents' perceptions of need support in the home environment as well as autonomous motivation in relation to physical activity and healthy eating behaviors. Although changes in motivational factors partially mediated changes in adolescents' quality of life, further intervention is likely to be necessary to significantly impact behavior change via motivational pathways proposed in self-determination theory.

Acknowledgments

This trial was funded by a Healthway Health Promotion Research Project Grant # 19938. The authors would like to thank participating families, program facilitators, and research staff.

References

- Buttitta, M., Iliescu, C., Rousseau, A., & Guerrien, A. (2014). Quality of life in overweight and obese children and adolescents: A literature review. *Quality of Life Research*, 23, 1117–1139. [PubMed doi:10.1007/s11136-013-0568-5](https://pubmed.ncbi.nlm.nih.gov/24811117/)
- Chatzisarantis, N.L.D., & Hagger, M.S. (2009). Effects of an intervention based on self-determination theory on self-reported leisure-time physical activity participation. *Psychology & Health*, 24, 29–48. [PubMed doi:10.1080/08870440701809533](https://pubmed.ncbi.nlm.nih.gov/1809533/)
- Chatzisarantis, N.L.D., Hagger, M.S., & Smith, B. (2007). Influences of perceived autonomy support on physical activity within the theory of planned behavior. *European Journal of Social Psychology*, 37, 934–954. [doi:10.1002/ejsp.407](https://doi.org/10.1002/ejsp.407)

- Cheon, S.H., & Reeve, J. (2013). Do the benefits from autonomy-supportive PE teacher training programs endure?: A one-year follow-up investigation. *Psychology of Sport and Exercise, 14*, 508–518. doi:10.1016/j.psychsport.2013.02.002
- Cheon, S.H., Reeve, J., & Moon, I.S. (2012). Experimentally based, longitudinally designed, teacher-focused intervention to help physical education teachers be more autonomy supportive toward their students. *Journal of Sport & Exercise Psychology, 34*, 365–396. PubMed
- Cheon, S.H., Reeve, J., Yu, T.H., & Jang, H.R. (2014). The teacher benefits from giving autonomy support during physical education instruction. *Journal of Sport & Exercise Psychology, 36*, 331–346. PubMed doi:10.1123/jsep.2013-0231
- Costa, S., Ntoumanis, N., & Bartholomew, K.J. (2015). Predicting the brighter and darker sides of interpersonal relationships: Does psychological need thwarting matter? *Motivation and Emotion, 39*, 11–24. doi:10.1007/s11031-014-9427-0
- Deci, E.L., & Ryan, R.M. (2000). The “what” and “why” of goal pursuits: human needs and the self-determination of behavior. *Psychological Inquiry, 11*, 227–268. doi:10.1207/S15327965PLI1104_01
- Edmunds, J., Ntoumanis, N., & Duda, J.L. (2007). Adherence and well-being in overweight and obese patients referred to an exercise on prescription scheme: A self-determination theory perspective. *Psychology of Sport and Exercise, 8*, 722–740. doi:10.1016/j.psychsport.2006.07.006
- Eime, R.M., Harvey, J.T., Craike, M.J., Symons, C.M., & Payne, W.R. (2013). Family support and ease of access link socio-economic status and sports club membership in adolescent girls: A mediation study. *The International Journal of Behavioral Nutrition and Physical Activity, 10*, 50. PubMed doi:10.1186/1479-5868-10-50
- Fenner, A.A., Howie, E.K., Davis, M.C., & Straker, L.M. (2016). Effects of a multi-disciplinary family-based healthy lifestyle intervention on psychological outcomes for overweight and obese adolescents and their parents: One-year follow-up of Curtin University’s Activity, Food and Attitudes Program. Manuscript submitted for publication.
- Fenner, A.A., Straker, L.M., Davis, M.C., & Hagger, M. S. (2013). Theoretical underpinnings of a need-supportive intervention to address sustained healthy lifestyle changes in overweight and obese adolescents. *Psychology of Sport and Exercise, 14*, 819–829. doi:10.1016/j.psychsport.2013.06.005
- Froiland, J.M. (2011). Parental autonomy support and student learning goals: A preliminary examination of an intrinsic motivation intervention. *Child and Youth Care Forum, 40*, 135–149. doi:10.1007/s10566-010-9126-2
- Gillison, F.B., Standage, M., & Skevington, S.M. (2006). Relationships among adolescents’ weight perceptions, exercise goals, exercise motivation, quality of life and leisure-time exercise behaviour: A self-determination theory approach. *Health Education Research, 21*, 836–847. PubMed doi:10.1093/her/cyl139
- Hagger, M.S., & Chatzisarantis, N.L.D. (2009). Assumptions in research in sport and exercise psychology. *Psychology of Sport and Exercise, 10*, 511–519. doi:10.1016/j.psychsport.2009.01.004
- Hagger, M.S., Chatzisarantis, N.L.D., Biddle, S.J.H., & Orbell, S. (2001). Antecedents of children’s physical activity intentions and behaviour: Predictive validity and longitudinal effects. *Psychology & Health, 16*, 391–407. doi:10.1080/08870440108405515
- Hagger, M.S., Chatzisarantis, N.L.D., & Harris, J. (2006). From psychological need satisfaction to intentional behavior: Testing a motivational sequence in two behavioral contexts. *Personality and Social Psychology Bulletin, 32*, 131–148. PubMed doi:10.1177/0146167205279905
- Hagger, M.S., Chatzisarantis, N.L.D., Hein, V., Pihu, M., Soós, I., & Karsai, I. (2007). The perceived autonomy support scale for exercise settings (PASSES): Development, validity, and cross-cultural invariance in young people. *Psychology of Sport and Exercise, 8*, 632–653. doi:10.1016/j.psychsport.2006.09.001
- Hagger, M.S., Chatzisarantis, N.L.D., Hein, V., Soos, I., Karsai, I., Lintunen, T., & Leemans, S. (2009). Teacher, peer and parent autonomy support in physical education and leisure-time physical activity: A trans-contextual model of motivation in four nations. *Psychology & Health, 24*, 689–711. PubMed doi:10.1080/08870440801956192
- Hirvensalo, M., & Lintunen, T. (2011). Life-course perspective for physical activity and sports participation. *European Review of Aging and Physical Activity, 8*, 13–22. doi:10.1007/s11556-010-0076-3
- Jacobs, N., Hagger, M.S., Streukens, S., De Bourdeaudhuij, I., & Claes, N. (2011). Testing an integrated model of the theory of planned behaviour and self-determination theory for different energy balance-related behaviours and intervention intensities. *British Journal of Health Psychology, 16*, 113–134. PubMed doi:10.1348/135910710X519305
- Jago, R., Sebire, S.J., Turner, K.M., Bentley, G.F., Goodred, J.K., Fox, K.R., . . . Lucas, P.J. (2013). Feasibility trial evaluation of a physical activity and screen-viewing course for parents of 6 to 8 year-old children: Teamplay. *The International Journal of Behavioral Nutrition and Physical Activity, 10*, 31. PubMed doi:10.1186/1479-5868-10-31
- Joussemet, M., Mageau, G.A., & Koestner, R. (2014). Promoting optimal parenting and children’s mental health: A preliminary evaluation of the How-to Parenting Program. *Journal of Child and Family Studies, 23*, 949–964. doi:10.1007/s10826-013-9751-0
- Krull, J.L., & MacKinnon, D.P. (1999). Multilevel mediation modeling in group-based intervention studies. *Evaluation Review, 23*, 418–444. PubMed doi:10.1177/0193841X9902300404
- Laursen, B., & Collins, W.A. (2009). Parent-child relationships during adolescence. In R.M. Lerner & L. Steinberg (Eds.), *Handbook of adolescent psychology* 3rd ed., pp. 3–42. Hoboken, NJ: John Wiley and Sons.
- Liska, A.E., Felson, R.B., Chamlin, M., & Baccaglini, W. (1984). Estimating attitude-behavior reciprocal effects within a theoretical specification. *Social Psychology Quarterly, 47*, 15–23. doi:10.2307/3033884
- Markland, D., & Tobin, V.J. (2004a). Further evidence for the mediating role of psychological need satisfaction between social-contextual supports and intrinsic motivation: A comparison of competing models. Unpublished manuscript.

- Markland, D., & Tobin, V.J. (2004b). A modification of the behavioral regulation in exercise questionnaire to include an assessment of amotivation. *Journal of Sport & Exercise Psychology*, *26*, 191–196.
- McCulloch, C.E., & Neuhaus, J.M. (2001). *Generalized linear mixed models*. Hoboken, New Jersey: John Wiley & Sons, Ltd.
- McLachlan, S., Spray, C., & Hagger, M.S. (2011). The development of a scale measuring integrated regulation in exercise. *British Journal of Health Psychology*, *16*, 722–743. [PubMed doi:10.1348/2044-8287.002009](#)
- Michie, S., & Prestwich, A. (2010). Are interventions theory-based? Development of a theory coding scheme. *Health Psychology*, *29*, 1–8. [PubMed doi:10.1037/a0016939](#)
- Ng, J.Y.Y., Ntoumanis, N., Thøgersen-Ntoumani, C., Deci, E.L., Ryan, R.M., Duda, J.L., & Williams, G.C. (2012). Self-determination theory applied to health contexts: A meta-analysis. *Perspectives on Psychological Science*, *7*, 325–340. [PubMed doi:10.1177/1745691612447309](#)
- Olds, T.S., Maher, C., Zumin, S., Peneau, S., Lioret, S., Castebon, K., . . . Summerbell, C. (2011). Evidence that the prevalence of childhood overweight is plateauing: data from nine countries. *International Journal of Pediatric Obesity*, *6*, 342–360. [PubMed doi:10.3109/17477166.2011.605895](#)
- Oude Luttikhuis, H., Baur, L.A., Jansen, H., Shrewsbury, V.A., O'Malley, C.O., Stolk, R.P., & Summerbell, C.D. (2009). Interventions for treating obesity in children. *Cochrane Database of Systematic Reviews*. [PubMed doi:10.1002/14651858.CD001872.pub2](#)
- Owen, K.B., Smith, J., Lubans, D.R., Ng, J.Y.Y., & Lonsdale, C. (2014). Self-determined motivation and physical activity in children and adolescents: A systematic review and meta-analysis. *Preventive Medicine*, *67*, 270–279. [PubMed doi:10.1016/j.ypmed.2014.07.033](#)
- Peinemann, F., Tushabe, D.A., & Kleijnen, J. (2013). Using multiple types of studies in systematic reviews of health care interventions - A systematic review. *PLOS ONE*, *8*, e85035. [PubMed doi:10.1371/journal.pone.0085035](#)
- Preacher, K.J., & Hayes, A.F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers*, *36*, 717–731. [PubMed doi:10.3758/BF03206553](#)
- Pulgarón, E.R. (2013). Childhood obesity: A review of increased risk for physical and psychological co-morbidities. *Clinical Therapeutics*, *35*, A18–A32. [PubMed doi:10.1016/j.clinthera.2012.12.014](#)
- Quaresma, A.M., Palmeira, A.L., Martins, S.S., Minderico, C.S., & Sardinha, L.B. (2014). Effect of a school-based intervention on physical activity and quality of life through serial mediation of social support and exercise motivation: The PESSOA program. *Health Education Research*, *29*, 906–917. [PubMed doi:10.1093/her/cyu056](#)
- Ryan, R.M., & Connell, J.P. (1989). Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and Social Psychology*, *57*, 749–761. [PubMed doi:10.1037/0022-3514.57.5.749](#)
- Ryan, R.M., Patrick, H., Deci, E.L., & Williams, G.C. (2008). Facilitating health behaviour change and its maintenance: Interventions based on self-determination theory. *The European Health Psychologist*, *10*(1), 2–5.
- Sallis, J.F., Prochaska, J.J., & Taylor, W.C. (2000). A review of correlates of physical activity of children and adolescents. *Medicine and Science in Sports and Exercise*, *32*, 963–975. [PubMed doi:10.1097/00005768-200005000-00014](#)
- St. George, S.M., Wilson, D.K., Schneider, E., & Alia, K.A. (2013). Project SHINE: Effects of parent-adolescent communication on sedentary behavior in African American adolescents. *Journal of Pediatric Psychology*, *38*, 997–1009. [PubMed doi:10.1093/jpepsy/jst027](#)
- Standage, M., Gillison, F.B., & Treasure, D.C. (2007). Self-determination and motivation in physical education. In M.S. Hagger & N.L.D. Chatzisarantis (Eds.), *Intrinsic motivation and self-determination in exercise and sport* (pp. 71–85). Champaign, IL: Human Kinetics.
- Straker, L.M., Howie, E.K., Smith, K., Fenner, A.F., Kerr, D.A., Olds, T.S., & Smith, A.J. (2014). The impact of Curtin University's Activity, Food and Attitudes Program on physical activity, sedentary time and fruit, vegetables and junk food consumption among overweight and obese adolescents: A waitlist controlled trial. *PLOS ONE*, *9*, e111954. [doi:10.1371/journal.pone.0111954](#)
- Straker, L.M., Smith, K.L., Fenner, A.A., Kerr, D.A., McManus, A., Davis, M.C., . . . Abbott, R.A. (2012). Rationale, design and methods for a staggered-entry, waitlist controlled clinical trial of the impact of a community-based, family-centred, multidisciplinary program focussed on activity, food and attitude habits (Curtin University's Activity, Food and Attitudes Program-CAFAP) among overweight adolescents. *BMC Public Health*, *12*, 471. [doi:10.1186/1471-2458-12-471](#)
- Varni, J., Seid, M., & Kurtin, P. (2001). PedsQL 4.0: Reliability and validity of the Pediatric Quality of Life Inventory Version 4.0 generic core scales in healthy and patient populations. *Medical Care*, *39*(8), 800–812. [PubMed doi:10.1097/00005650-200108000-00006](#)
- Warren, J.M., Golley, R.K., Collins, C.E., Okely, A.D., & Jones, R.A. (2007). Randomised controlled trials in overweight children: Practicalities and realities. *International Journal of Pediatric Obesity; IJPO*, *2*, 73–85. [PubMed doi:10.1080/17477160601133671](#)
- Wild, T.C., & Enzle, M.E. (2002). Social contagion on motivational orientations. In E.L. Deci & R.M. Ryan (Eds.), *Handbook of self-determination research* (pp. 141–157). Rochester, NY: University of Rochester Press.
- Williams, G.C., McGregor, H.A., Sharp, D., Levesque, C., Kouides, R.W., Ryan, R.M., & Deci, E.L. (2006). Testing a self-determination theory intervention for motivating tobacco cessation: Supporting autonomy and competence in a clinical trial. *Health Psychology*, *25*, 91–101. [PubMed doi:10.1037/0278-6133.25.1.91](#)
- Williams, G.C., Teixeira, P.J., Carraça, E.V., & Resnicow, K. (2011). Physical wellness, health care, and personal autonomy. *Cross-Cultural Advancements in Positive Psychology*, *1*, 133–162. [doi:10.1007/978-90-481-9667-8_7](#)

Manuscript submitted: April 13, 2015

Revision accepted: December 6, 2015