

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

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Abstract

The current study explored whether a multi-disciplinary 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 pre-intervention (within-participant control), immediately following intervention, and at 3, 6, and 12 months follow-up. Parents were trained in need-supportive behaviours within the broader context of an 8-week multi-disciplinary 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 one-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 multi-disciplinary family-based interventions that aim to train parents in need-supportive behaviours.

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

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2 Quality of Life During a Multi-Disciplinary Family-Based Intervention for Overweight
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4 Given evidence of high rates of obesity in adolescents (Olds et al., 2011) and the
5 associated maladaptive psychosocial and physical outcomes (Pulgarón, 2013), adolescence has
6 been identified as a critical period for behavioural interventions to manage obesity (Hirvensalo &
7 Lintunen, 2011). Reviews of the literature suggest that interventions targeting adolescent obesity
8 are most likely to be effective if placed within a multi-disciplinary family-based healthy lifestyle
9 context (Oude Luttikhuis et al., 2009). To ensure efficacy and replication researchers have also
10 advocated for understanding theory-based mediators proposed to influence change associated
11 with intervention (Michie & Prestwich, 2010).

12 One theory that has been shown to be effective in explaining variance in psychosocial
13 and physical outcomes in the context of environmental supports is self-determination theory
14 (Deci & Ryan, 2000). According to the theory, individuals have three basic, innate needs:
15 autonomy, competence, and relatedness. The extent to which one's environment is able to satisfy
16 these needs, through the provision of autonomy support, structure, and involvement, is posited to
17 predict the degree to which a behaviour is performed for more autonomous (e.g., self-
18 determined) rather than controlled reasons (Chatzisarantis, Hagger, & Smith, 2007).
19 Environmental supports are therefore proposed to predict psychosocial and physical outcomes
20 via an individual's degree of autonomous motivation (Ryan, Patrick, Deci, & Williams, 2008).

21 While a growing body of evidence supports the utility of autonomous motivation in
22 predicting psychosocial and behavioural outcomes (Williams, Teixeira, Carraça, & Resnicow,
23 2011), as well as perceptions of need-support in predicting autonomous motivation

1 (Chatzisarantis & Hagger, 2009), only a handful of studies have explored the mediation pathway
2 proposed in self-determination theory in relation to health promotion interventions for
3 adolescents (Ng et al., 2012). These studies have been successful in demonstrating support for
4 the indirect relationship from perceptions of need-support to behavioural and psychosocial
5 outcomes via autonomous motivation. However, environmental manipulation of need-support
6 has been primarily conducted in physical education contexts (Standage, Gillison, & Treasure,
7 2007) despite and the role of parents in predicting proposed pathways in self-determination
8 theory (Sallis, Prochaska, & Taylor, 2000; Wild & Enzle, 2002) and the equivalent benefits of
9 considering healthy eating contexts (Buttitta, Iliescu, Rousseau, & Guerrien, 2014).

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

19 A further limitation of previous studies is that few have adequately accounted for
20 temporal changes in motivational constructs. Better approaches that account for changes in these
21 factors are likely to have greater value when it comes to understanding how behaviour changes
22 over time. A few studies adopting cross-lagged panel designs to predict change and control for
23 the stability of motivational constructs over time have been conducted in the context of social

1 cognitive models of health behaviour (Hagger, Chatzisarantis, Biddle, & Orbell, 2001; Jacobs,
2 Hagger, Streukens, De Bourdeaudhuij, & Claes, 2011; Liska, Felson, Chamlin, & Baccaglini,
3 1984). However, there has been no research examining the effect of dynamic changes in self-
4 determination theory process variables (e.g., parent need-support and adolescent motivation)
5 within the context of healthy lifestyle interventions. A major innovation of the present study is
6 the examination of change in the quality of life and motivational variables over time, an
7 approach which is in contrast to the typically ‘static’ perspective adopted in many studies testing
8 psychological theories and models in health contexts.

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

20 In accordance with the theoretical framework of self-determination theory (Deci & Ryan,
21 2000), we hypothesized that: (1) Adolescent quality of life (and perceptions of parent need-
22 support and autonomous motivation in relation to physical activity and healthy eating) would be
23 greater during the post-intervention, 3, 6, and 12-month follow-up assessments in comparison to

1 the pre-intervention assessment; (2) The rate of change in adolescent quality of life (and
2 perceptions of parent need-support and autonomous motivation in relation to physical activity
3 and healthy eating) would be greater during the intervention and maintenance periods compared
4 to the waitlist-period; (3) Across all assessment points changes in adolescent quality of life
5 would be related to changes in perceptions of parent need-support; and (4) Predicted changes in
6 quality of life would be mediated by changes in adolescent autonomous motivation in relation to
7 both physical activity and healthy eating.

8 **Methods**

9 **Study Design**

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

17 Participants completed baseline assessments, then waitlisted for one school term (3
18 months) before completing pre-intervention assessments to provide a within-participant control.
19 Assessments were then conducted immediately following the intensive intervention and at 3, 6,
20 and 12 months follow-up. The intensive 8-week (two hour bi-weekly sessions) intervention was
21 delivered by multi-disciplinary teams of instructors (e.g., physiotherapists/exercise physiologists,
22 dieticians, and psychologists) across three locations in Western Australia with a high proportion
23 of low socio-economic status residents. Program entry was staggered across three cohorts

1 (February, May, August, 2012) to control for seasonal variations and external bias. The study is
2 registered with the Australia and New Zealand Clinical Trials Registry (No. 12611001187932),
3 and was approved by Curtin University's Human Research Ethics Committee (HR105/2011). A
4 detailed description of the study design can be found in the published protocol (see Straker et al.,
5 2012).

6 **Participants**

7 Families were included in the study if adolescents were between 11 to 16 years of age,
8 had a BMI greater than the 85th percentile with respect to their age and sex, passed a medical
9 screening conducted by a general practitioner, were willing to attend intervention sessions and
10 pre- and post-program assessments alongside the household parent predominately responsible for
11 supporting lifelong physical activity and eating habits, and were not undergoing treatment for a
12 psychological disorder or obese due to a medical condition. Following recruitment targeted
13 primarily in low socio-economic areas surrounding program locations (e.g., health professionals,
14 local schools, community newspapers, flyers), 123 potential families expressed interest in the
15 study and 69 adolescents/parent pairs provided informed consent and enrolled in the study. Flow
16 of participants is described in more detail elsewhere (Straker et al., 2015).

17 **Intervention**

18 During the first hour of all program sessions adolescents engaged in physical activity
19 routines guided by the physiotherapist/exercise physiologist while parents received educational
20 information. Adolescents and parents jointly explored educational concepts in the second hour.
21 Prior to program delivery, facilitators were trained to provide need-supportive environments to
22 promote autonomous motivation for behaviour change in adolescents and parents (to support
23 adolescents). Facilitators also guided parents in methods for delivering need-supportive

1 behaviours to promote adolescent engagement in healthy lifestyle behaviours. Parent training
2 was conducted in accordance with previous evidence-based guidelines (Cheon, Reeve, & Moon,
3 2012) during the parent-only hour of the second intervention session. Behaviour-change
4 techniques inclusive of autonomy support, structure, and involvement were equally targeted with
5 definitions and examples provided alongside role modelling opportunities. Mediators of changes
6 in outcomes due to intervention (feeling a sense of autonomy, competence, and relatedness) were
7 also detailed alongside examples of key outcome variables expected to change (i.e., adolescents'
8 autonomous motivation, adherence to healthy lifestyle behaviours, and well-being).

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

19 Goal setting content was integrated with self-determination theory to provide a
20 motivating structure for implementing behaviour change by asking adolescents and parents to set
21 distal and proximal goals that were specific, difficult, and intrinsic in content and autonomously
22 motivated. Parent goals mapped directly onto adolescent goals to ensure adolescents had choice
23 in their goals and parents could provide home environments to enhance competence in goal-

1 related areas as well as support relatedness through involvement in goal setting processes.
2 Further details of the theoretical underpinnings, protocol for training parents in need-supportive
3 behaviours, and program content has been published elsewhere Fenner, Straker, Davis, &
4 Hagger, 2013; Straker et al., 2014).

5 **Measures**

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

12 **Autonomous motivation.** Adolescent autonomous motivation for physical activity was
13 measured using a modified version of the revised Behavioural Regulation in Exercise
14 Questionnaire Version 2 (BREQ-2; Markland & Tobin, 2004b) and the Integrated Regulation
15 Scale for Exercise Behaviour (McLachlan, Spray, & Hagger, 2011). Adolescent autonomous
16 motivation for healthy eating behaviours was measured using an adapted version of Ryan and
17 Connell's (1989) Perceived Locus of Causality for Diet (PLOC; Hagger, Chatzisarantis, &
18 Harris, 2006) and the Integrated Regulation Scale for Exercise Behaviour (McLachlan et al.,
19 2011). Adolescents indicated their feelings about participating in physical activity and healthy
20 eating behaviours using a four-point scale ranging from 1 (*not at all true*) to 4 (*very true*). Mean
21 scores for each type of motivation were assigned the following weights and summed to form a
22 single relative autonomy index (RAI) for physical activity and healthy eating, respectively:
23 intrinsic +3; integrated +2; identified +1; introjected -1; external -2; amotivation -3.

1 **Quality of life.** Adolescent quality of life was measured using the Paediatric Quality of
2 Life – Teen Report (PedsQL; Varni, Seid, & Kurtin, 2001). The inventory comprises generic
3 core scales measuring physical, emotional, social, and school functioning, with the total,
4 physical, and psychosocial health summary scores having acceptable validity and reliability. A
5 five-point scale was used ranging from 0 (*never a problem*) to 4 (*almost always a problem*), and
6 values reverse-scored and linearly transformed to a zero to 100 scale (0 = 100, 1 = 75, 2 = 50, 3
7 = 25, 4 = 0), such that higher scores reflected better quality of life.

8 **Statistical Analyses**

9 Only participants with at least two assessments were included in statistical models ($n =$
10 56). Missing values were accounted for using likelihood-based estimation which uses all
11 available information to produce final estimates. Data were inspected for potential outliers and
12 data entry errors. Two outliers were identified (i.e., > 3 SD from the mean) during follow-up
13 periods for adolescent perceptions of parent need-support. These outliers remained in the data set
14 due to a lack of influence on significant differences in outcomes. Normality of distribution was
15 assessed using histograms, boxplots, and values of skewness and kurtosis. Standard errors were
16 bootstrapped for all analyses with 1,000 replications to adjust for non-normally distributed
17 variables (Preacher & Hayes, 2004). Descriptive statistics were calculated at baseline for
18 participants who completed the intervention and maintenance periods, as well as for participants
19 who dropped-out either during the waitlist or maintenance period. Comparisons were made
20 between the three groups using ANOVA and chi-square analyses.

21 Our four hypotheses were tested by conducting the following analyses:

22 1. To test changes in adolescent quality of life (and perceptions of parent need-support
23 and autonomous motivation for physical activity and healthy eating) at post-intervention, 3, 6,

1 and 12-months follow-up in comparison to pre-intervention values, separate generalized linear
2 mixed models were used (McCulloch & Neuhaus, 2001) with *a priori* linear contrasts to
3 compare differences in mean point estimates at each time point to those at pre-intervention. As
4 measures were repeated within participants (six assessments per person), an exchangeable
5 correlation structure and random intercepts for each individual were used to account for the
6 correlation between assessments within individuals. No explicit adjustment was made to control
7 for multiple comparisons, and as such 95% confidence intervals are presented for all parameter
8 estimates along with *p*-values where appropriate.

9 2. To assess dynamic changes in constructs across the duration of the study, monthly
10 rates of change in adolescent quality of life (as well as perceptions of parent need-support and
11 autonomous motivation for physical activity and healthy eating) were calculated over the
12 following periods to allow for comparison: waitlist (baseline and pre-intervention), intervention
13 (pre-intervention to post-intervention), and the 12-month maintenance period (post-intervention
14 and 12-month follow-up). Calculating monthly rates of change also controlled for the varying
15 amount of time between assessments while allowing the waitlist period to serve as a within-
16 participants comparison.

17 3. To explore relationships among these self-determination theory constructs and quality
18 of life outcomes, exploratory analyses were conducted using Spearman's correlation.

19 4. Due to the waitlist control within-participant design, linear mixed multilevel mediation
20 models were used to explore mediation effects of changes in perceived parent need-support and
21 changes in autonomous motivation on changes in quality of life. The model assessed the
22 relationship between the variables across all time points, with the multilevel mediation model
23 accounting for the correlation between repeated measures. Multilevel mediation is similar to

1 mediation models using linear regression in which three models are tested (Krull & MacKinnon,
2 1999). The models are presented in Figures 1 and 2. We first assessed the direct effect of
3 whether changes in perceived parent need-support for physical activity predicted changes in
4 quality of life (see Figure 1). Second, we assessed the direct effect of changes in autonomous
5 motivation for physical activity predicting changes in quality of life (path *b*). The indirect effect
6 is the product of the path coefficients $a \times b$. Finally, the mediated path assessed whether changes
7 in perceived parent need-support for physical activity (the predictor) predicted changes in quality
8 of life (the outcome) when adjusted for changes in autonomous motivation for physical activity
9 (the mediator) (path c' , Figure 1). The second model (healthy eating) explored the same
10 pathways in relation to healthy eating (see Figure 2). All analyses were performed using Stata/IC
11 v 13.0 (StataCorp LP, College Station TX, USA).

12 Results

13 Baseline Characteristics

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

17 Direct Effects of the Intervention

18 **Perceptions of parent need-support.** Adolescent perceptions of parent need-support for
19 physical activity and healthy eating did not change significantly during the waitlist period (e.g.,
20 between baseline and pre-intervention), as shown in Table 1. Following the intensive 8-week
21 intervention, a significant increase was demonstrated in point estimates in perceptions of parent
22 need-support for physical activity ($M = 5.84$, $SE = 0.12$ compared to $M = 4.83$, $SE = 0.10$, $p <$
23 $.001$) and healthy eating ($M = 5.99$, $SE = 0.10$ compared to $M = 5.28$, $SE = 0.09$, $p < .001$). Point

1 estimates during the 12-month maintenance period remained significantly elevated from pre-
2 intervention. In relation to physical activity and healthy eating, the monthly rates of change were
3 significantly different during the intervention period compared to the waitlist period. Monthly
4 rates of change were not significantly different between maintenance and waitlist periods.

5 **Autonomous motivation.** No significant changes were shown in point estimates of
6 adolescent autonomous motivation for physical activity and healthy eating from baseline to pre-
7 intervention during the waitlist period (see Table 1). Following the intensive 8-week
8 intervention, there were significant improvements in point estimates in adolescent autonomous
9 motivation for physical activity ($M = 6.76$, $SE = 0.47$ compared to $M = 4.96$, $SE = 0.35$, $p <$
10 $.001$) and healthy eating ($M = 5.68$, $SE = 0.43$ compared to $M = 3.77$, $SE = 0.27$, $p <$
11 $.001$). Point estimates also remained significantly elevated during the maintenance period compared to pre-
12 intervention levels. The monthly rate of change in autonomous motivation for physical activity
13 and healthy eating over the intervention period was also significantly different to the rate of
14 change in each variable during the waitlist period. Monthly rates of change during the
15 maintenance period were not significantly different to rates of change during the waitlist period.

16 **Quality of life.** No significant changes were demonstrated during the waitlist control
17 period. Immediately following intervention point estimates for adolescent quality of life were
18 significantly improved in comparison to levels reported at pre-intervention ($M = 75.27$, $SE =$
19 1.13 compared to $M = 70.64$, $SE 1.06$, $p = .004$), and changes were retained over the 12-month
20 maintenance period. During intervention and maintenance periods no significant differences
21 were demonstrated in monthly rates of change.

1 **Associations Among Adolescent Variables**

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

5 **Mediation Analyses**

6 In the physical activity model, changes in perceptions of parent need-support for physical
7 activity had a positive statistically significant total effect on changes in quality of life ($\beta = 2.84$, p
8 $< .001$, 95% CI [1.79, 3.90]). There was also a significant indirect effect of changes in
9 autonomous motivation for physical activity partially mediating this relationship ($\beta = 1.17$, $p <$
10 $.001$, 95% CI [0.70, 1.65]). In the healthy eating model, changes in perceptions of parent need-
11 support for healthy eating had a positive statistically significant total effect on changes in quality
12 of life ($\beta = 2.77$, $p < .001$, 95% CI [1.46, 4.08]). Again, this relationship was mediated by
13 changes in autonomous motivation for healthy eating with a small, but statistically significant
14 indirect effect ($\beta = 0.70$; 95% CI = 0.24, 1.15, $p = .003$).

15 **Discussion**

16 In the current study, adolescents' perceptions of parent need-support in relation to
17 physical activity and healthy eating behaviours were shown to increase immediately following
18 intervention, and these changes remained elevated from pre-intervention levels at one-year
19 follow-up. Further, results indicate an intervention aimed at promoting parents' demonstration of
20 need-supportive behaviours was successful at improving adolescents' autonomous motivation for
21 both physical activity and healthy eating behaviours immediately following intervention, with
22 changes from pre-intervention levels maintained at one-year follow-up. In addition, the
23 intervention was successful in improving adolescent quality of life from pre-intervention to one-

1 year follow-up. Finally, the influence of changes in adolescent perceptions of parental need-
2 support on changes in quality of life was partly mediated by changes in autonomous motivation
3 in relation to both physical activity and healthy eating behaviours.

4 The current study is the first to report changes in overweight and obese adolescents'
5 perceptions of parents' need-support and autonomous motivation in relation to both physical
6 activity and healthy eating behaviours following parents' receipt of training in need-supportive
7 behaviours. Furthermore, the research is also unique as it focuses on changes in outcomes over
8 time rather than the 'static' predictions often identified in cross-sectional studies (Hagger &
9 Chatzisarantis, 2009). Previous studies in health-promotion contexts aiming to train parents
10 based on the tenants of self-determination theory have also been limited primarily to parents of
11 young children (e.g., Jago et al., 2013), and no studies have explored changes in mechanisms
12 based on tenants of self-determination theory by mediation analysis. Our findings suggest that
13 training parents in need-supportive behaviours can improve adolescents' perceptions of need-
14 support for physical activity and healthy eating within the home environment as well as their
15 autonomous motivation to engage in healthy lifestyle behaviours. However, slight reductions in
16 intensity of changes across the maintenance period suggests that in order to maintain the full
17 extent of gains made in adolescent outcomes parents may require post-intervention support.
18 Booster sessions and follow-up group discussions previously shown to be useful in training
19 physical education teachers (Cheon & Reeve, 2013; Cheon, Reeve, Yu, & Jang, 2014) may
20 prove fruitful during maintenance periods in family-based interventions targeting overweight and
21 obese adolescents.

22 In support of the proposed intervention models based on self-determination theory,
23 relationships among all proposed variables were also shown to be significantly and positively

1 correlated across the waitlist, intervention, and maintenance periods. These findings corroborate
2 and extend previous findings in physical education settings (Quaresma, Palmeira, Martins,
3 Minderico, & Sardinha, 2014) by demonstrating that in relation to both physical activity and
4 healthy eating, changes in adolescent perceptions of parent need-support is associated with
5 changes in adolescent autonomous motivation, and these variables are also directly associated
6 with changes in adolescent quality of life.

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

1 contrast to indicators of well-being, behavioural outcomes may therefore have been impeded by
2 barriers and access to tangible resources, despite increases in autonomous motivation.

3 Future studies should consider placing even greater emphasis on potential barriers and
4 problem solving the sourcing of healthy lifestyle methods both during intervention and in follow-
5 up booster sessions. Similarly, it may be of benefit to assess parents' experiences of
6 implementing need-supportive behaviours to better understand potential barriers (i.e., costs and
7 benefits). Another consideration is that previous studies based on self-reported physical activity
8 have demonstrated a stronger link between autonomous motivation and physical activity than
9 objective measures of behaviour (Owen et al., 2014). Mediation was supported in the current
10 study in relation to self-reported quality of life, in contrast to the limited changes in healthy
11 eating behaviours that placed less emphasis on subjective recall (e.g., 3-day food diaries) and
12 objective measures of physical activity and sedentary behaviour. Given the importance of
13 parents' role in adolescents' development of lifelong behaviours, further research is needed using
14 objective measures of physical activity and less subjective measures of healthy eating (i.e., 3-day
15 food diaries) to determine the strength of this relationship following parents' receipt of training.
16 Multiple perspectives from spouses and external observers may also be useful in assessing parent
17 need-support. However, one would have to consider potential for the presence of an observer to
18 bias parent behaviours, threat to validity if a spouse was not fully aware of need-supportive
19 behaviours demonstrated, and the absence of spouses in single-parent households.

20 **Strengths and Limitations**

21 Our study has several strengths. To our knowledge, this is the first study to explore self-
22 determination theory-based mediators within the context of an intervention aimed at training
23 parents of overweight and obese adolescents in need-supportive behaviours. The approach of

1 examining change in motivational variables and quality of life outcomes over time is in contrast
2 to the typically ‘static’ perspective most commonly adopted in studies testing motivational
3 theories in health contexts. In addition, theoretically-based mechanisms underlying changes were
4 assessed over a one-year maintenance period following intervention. Assessment of theory-based
5 mediation pathways in the current study suggest that overweight and obese adolescents may
6 benefit from parents’ receipt of training in need-supportive behaviours. However, the lack of
7 analyses regarding behavioural and mental health outcomes limits the interpretation of these
8 findings beyond quality of life outcomes.

9 A potential limitation of the study was use of a within-participants comparison instead of
10 a concurrent control group. However, the ethical issues of withholding a plausible intervention
11 from a population in need for the duration required for long-term follow-up has been noted
12 (Warren, Golley, Collins, Okely, & Jones, 2007), and outcomes from prospective studies suggest
13 limited improvements in autonomous motivation, parenting behaviours, indices of well-being,
14 and healthy lifestyle behaviours in the absence of intervention (Gillison, Standage, &
15 Skevington, 2006; Hagger et al., 2009). Our exclusive focus on autonomous motivation was
16 based on theory (Deci & Ryan, 2000) and evidence (Owen et al., 2014) identifying it as the most
17 important environmental impact on adherence to health behaviours according to self-
18 determination theory (Cheon et al., 2012). Nevertheless, recent attention has been directed
19 toward need-thwarting behaviours which may be displayed concurrent to autonomy-supportive
20 behaviours (Costa, Ntoumanis, & Bartholomew, 2015). We look to future research that
21 incorporates measures of need-thwarting behaviours alongside autonomy-support to further
22 elucidate the role of controlling interpersonal factors in health-related behavioural interventions.

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

9 **Conclusion**

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

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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 (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)*	-.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)*	-.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, 0.34)	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)*	-.029 (-0.14, 0.79)
HRQL	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; HRQL = 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	
HRQL	.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; HRQL = quality of life.

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

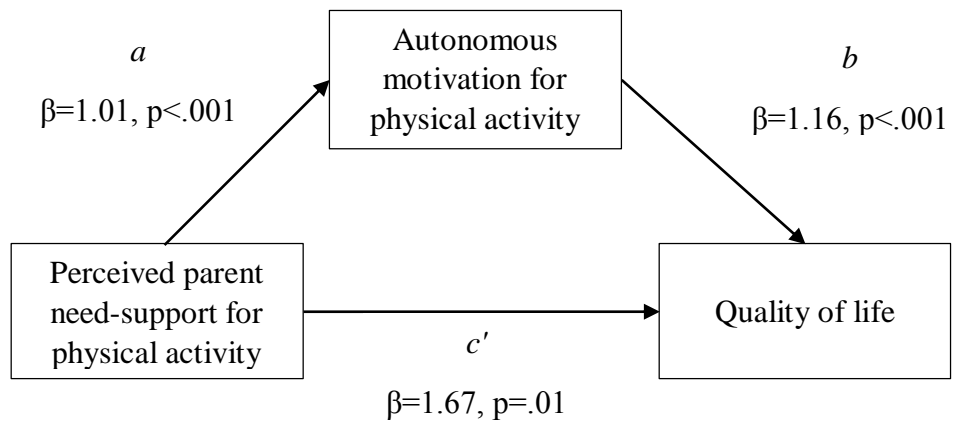


Figure 1. Physical activity model with unstandardized beta coefficients.

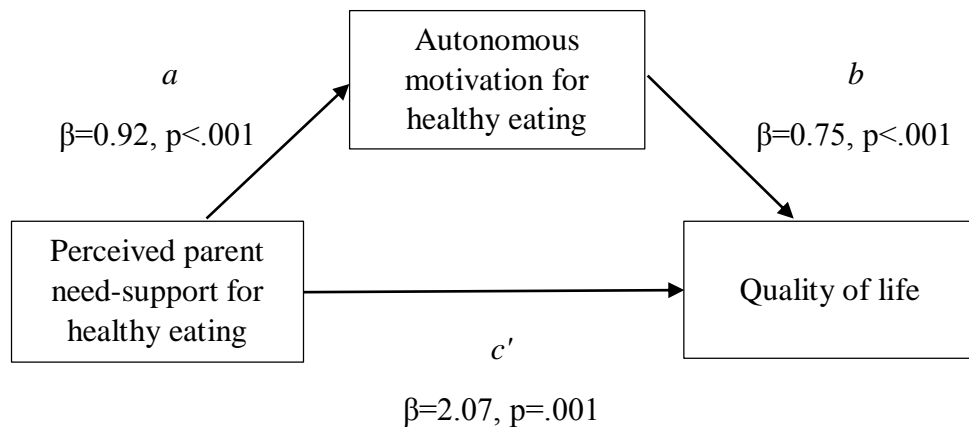


Figure 2. Healthy eating model with unstandardized beta coefficients.