



Effects of a group-based exercise and self-regulatory intervention on obese adolescents' physical activity, social cognitions, body composition and strength: A randomized feasibility study

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Abstract

This feasibility study assessed the effects of an exercise plus group-based self-regulatory skills intervention on obese youths' physical activity, social cognitions, body composition and strength. Forty-three obese youth (male = 13, BMI > 95th percentile; 10–16 yrs) completed this 12-week intervention. Assessments were taken at baseline, week 6, 13 and 12 weeks post-intervention (week 24). Although no attention control group (i.e. exercise only) was included in this study, participants engaged in significantly more self-reported physical activity at weeks 13 and 24 as compared to baseline. Social cognitions, body composition and strength were also positively impacted suggesting this intervention technique may be feasible for treating obese adolescents.

Keywords

adolescence, exercise behaviour, obesity, self-efficacy, social cognitions

Childhood and adolescent obesity is a major health concern for youth in developed countries worldwide. Ogden and colleagues (2010) recently reported that 31.7% of American youth (ages 2–19) are overweight or obese. In North America and certain parts of Europe, the rate of childhood obesity (ages 6–18) has tripled over the last three decades (Wang and Lobstein, 2006). The prevalence of obesity in youth is of concern because of its connection with type 2 diabetes, cardiovascular disease, psychosocial problems (e.g. depression and low self-esteem) and adult obesity (Deckelbaum and Williams,

2001; Freedman et al., 2001; Gungor et al., 2005). Furthermore, the cost of treating these largely preventable (Malina, 2001; Tuomilehto

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et al., 2001), debilitating diseases associated with adolescent obesity is immense (Birmingham et al., 1999).

Physical inactivity is strongly related to adolescent obesity (Page et al., 2005). The Canadian physical activity guidelines suggest that in order to accrue health benefits, youth should accumulate at least 60 minutes of moderate to vigorous physical activity per day (Tremblay et al., 2011). Disappointingly, the Canadian Health Measures Survey (Colley et al., 2011) found that only 7% of Canadian youth engage in this level of activity. In consideration of effective methods of increasing physical activity, Van Sluijs and colleagues (2007) reported that multicomponent interventions involving schools, communities and families are likely to help in getting adolescents more active. Indeed, numerous interventions have attempted to use such a multicomponent intervention to increase physical activity among obese youth; however, two recent reviews of such studies concluded that more theoretically driven, creative interventions are required to enhance physical activity interventions among obese youth (Bogle and Sykes, 2011; Cliff et al., 2010). From a theoretical standpoint, it has been suggested that making lifestyle changes, including adhering to complex health behaviours such as physical activity, requires self-regulatory effort and forethought. Social cognitions play an integral role in predicting volitional behaviour in social cognitive theory (SCT; Bandura, 1986) and more recently in a model of exercise adherence detailed by Rothman (2000).

SCT is one of the most prominent theories of health behaviour change and suggests that an individual's behaviour is a product of the interrelationships between the person and the environment (Bandura, 1986). Both an individual's confidence to engage in and regulate behaviour (i.e. self-regulatory efficacy (SRE)) as well as perceived outcomes from the behaviour in question (outcome expectations (OE)) are proposed to influence behavioural engagement (Bandura, 1986, 1997). In

children specifically, both task and barrier self-efficacy (SE; key subcomponents of SRE), have been reported as particularly strong predictors of physical activity behaviour (Foley et al., 2008; Trost et al., 2001, 2003). Furthermore, OEs have been found to mediate dietary and physical activity behaviour change among youth (Cerin et al., 2009; Zakarian et al., 1994). However, yet to be determined is if an intervention designed to target both OE and specific subtypes of SRE can help obese youth adopt and maintain an active lifestyle.

From a related theoretical perspective, Rothman (2000) suggested that an individual's cognitive appraisal of both enjoyment and satisfaction with outcomes from previous efforts are important predictors of physical activity behaviour. Specifically, perceiving behaviour as enjoyable is posited to influence adoption of a new behaviour (i.e. the first few weeks of beginning a new physical activity regime), whereas satisfaction with outcomes from previous efforts is more likely to influence behaviour adherence (i.e. long-term physical activity behaviour). Rothman's predictions coincide well with SCT, which describes individuals as rational decision-makers when making behavioural choices (Bandura, 1986). As such, behaviours that are anticipated to be enjoyable are likely to be attempted and behaviours that have resulted in satisfying outcomes are likely to be continued. Satisfaction has been examined previously in an SCT-based intervention, which found adolescent female's satisfaction with current physical activity positively predicted future physical activity behaviour (Dishman et al., 2004). If the positive outcomes obese adolescents anticipate achieving from a weight loss programme are met, greater satisfaction may result, which could translate into long-term adherence to healthy lifestyle behaviours (i.e. regular physical activity).

While some childhood obesity studies have demonstrated the predictive utility of SRE, OE and satisfaction, few have successfully *targeted* these cognitions in an intervention, nor

examined their potential mechanistic role on obesity parameters (Baranowski et al., 1997; Sharma, 2006). When attempting to translate evidence from these descriptive studies into interventions, a challenge is finding some means of teaching the self-regulatory skills to participants in an environment that facilitates and motivates participants' practice of these new found skills. One possible delivery format for teaching self-regulatory skills that holds both research and practice promise is the use of a 'group as an agent of change' (Brawley et al., 2000).

Group-mediated cognitive-behavioural (GMCB) interventions

Brawley and colleagues (2000) developed the GMCB model, which aims to facilitate learning of independent self-regulatory skills for physical activity through the use of a group. Typically delivered in weekly sessions, the first objective is to develop a cohesive group. This can be achieved through the participants deciding on a name for the 'team' and a team cheer (i.e. a motivational song; Brawley et al., 2000). Over the course of the rest of the sessions (typically eight to 12 weeks total), the group sessions revolve around discussing physical activity behaviours from the past week, self-regulatory skills, benefits of physical activity (i.e. OE) and supporting group members in achieving independent and group physical activity goals. While the GMCB approach teaches self-regulatory skills in a group setting, the focus is on helping each participant learn how to self-regulate their behaviour *independently*. For example, participants practise setting their own physical activity goals, schedule regular physical activity and come up with solutions to overcome barriers that influence them personally (i.e. develop SRE). In order to deter dependence on the group, the structured exercise sessions gradually taper off (i.e. decrease in number of

sessions per week as the programme progresses) which encourages participants to rely increasingly on their own abilities to self-regulate independently and engage in physical activity (Brawley et al., 2000).

Brawley and colleagues (2000) suggest that GMCB interventions facilitate behaviour change through the powerful influence of the group, which can 'use its social pressure, motivation and support to encourage members to adopt the cognitive-behavioural changes'. Members of the group are taught, and subsequently practise, the self-regulatory skills deemed critical for physical activity adherence. If individuals are to change their behaviour they must value the outcome of the behaviour, believe they can produce the desired outcome and believe that the outcome will result from successfully completing the behaviour (Rodgers and Brawley, 1991). Therefore, in a GMCB intervention it is imperative to target both OE (anticipated outcomes of engaging in the behaviour) and SRE (confidence in ability to regulate behaviour), specifically in how they relate to *independent* physical activity.

The success of the GMCB model has been demonstrated in a multitude of unique populations over the past decade (postnatal women: Cramp and Brawley, 2006; elderly adults: Brawley et al., 2000; cardiac rehabilitation patients: Focht et al., 2004; Rejeski et al., 2003), all of which have reported positive adherence with their respective exercise programmes. Specifically, these GMCB interventions lead to greater improvements in participants' frequency of exercise (Brawley et al., 2000, 2003; Rejeski et al., 2003), long-term exercise adherence (Brawley et al., 2000; Cramp and Brawley, 2006; Rejeski et al., 2003) and fitness (Rejeski et al., 2003) as compared to participants in control groups. Maintenance of OE and increases in both barrier and mobility SE have also been reported (Cramp and Brawley, 2006; Rejeski et al., 2003); both social cognitions that a GMCB intervention aims to influence.

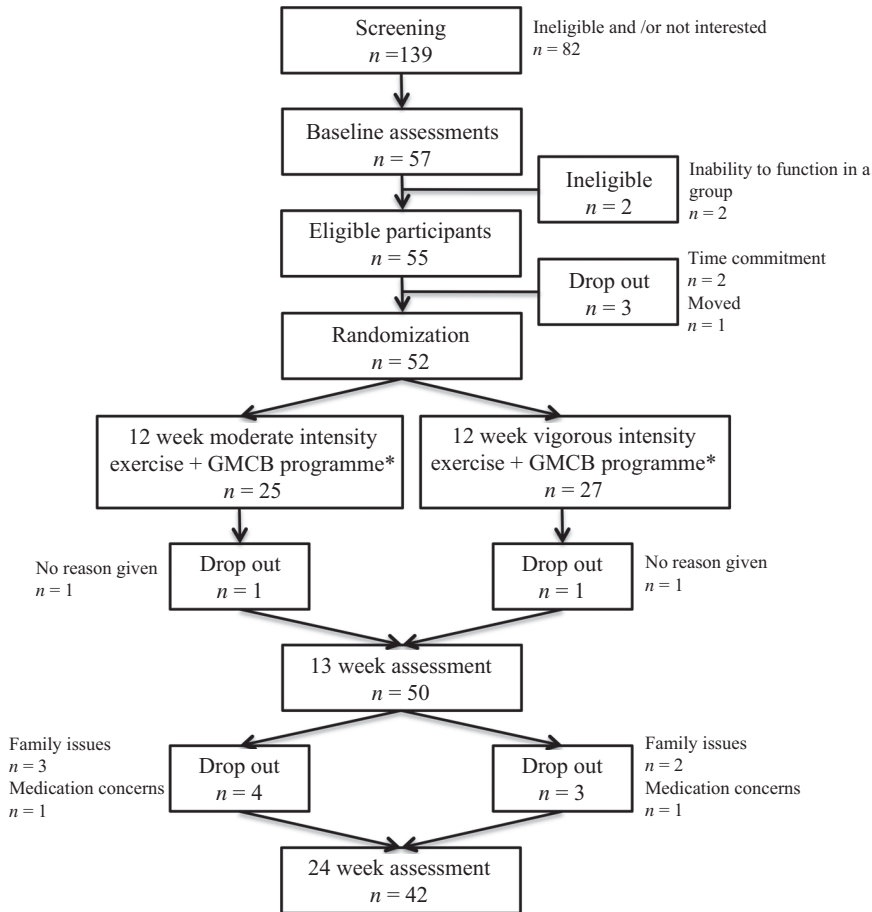


Figure 1. Participant flow through the 12-week REACH exercise plus GMCB programme.
 *Note that participants in both exercise conditions were also randomized to take either metformin or placebo.

The REACH Intervention: an overview

The intervention discussed in this article was part of a larger, multidisciplinary adolescent obesity clinical trial entitled REACH. REACH is a two-year randomized double-blinded metformin/placebo and lifestyle intervention. Details of the REACH intervention have been published previously (reference blinded; see the Appendix for a brief summary of procedures pertinent to the current study). All participants were randomized to take either

metformin or placebo, and then randomized to engage in either moderate or vigorous intensity exercise (aerobic and resistance exercises). Everyone participated in identical weekly GMCB sessions for the first 12 weeks of the two-year intervention (see Fig. 1 for a flow diagram). Following the 12-week intervention, participants remained on metformin or placebo, engaged in weekly exercise sessions at a local community centre, attended family sessions with a dietician and a social worker and received medical monitoring. The current study focuses on the feasibility of the 12-week

exercise plus GMCB intervention and includes post-intervention follow-up assessments of independent physical activity, social cognitions, body composition and strength at weeks 13 and 24. Note that the primary outcome for the two-year intervention is body mass index (unpublished), thus the outcomes reported in this study are secondary outcomes. Exercise and drug condition were included as covariates in the analyses. This study was conducted after obtaining institutional ethical approval and in accordance with APA guidelines.

Objectives and hypotheses

There were four objectives of this feasibility trial. Our primary objective was to examine the effects of the exercise plus GMCB intervention on obese youth's *independent* physical activity (i.e. physical activity outside of the study exercise sessions) after intervention completion. It was hypothesized that all participants would engage in more independent physical activity immediately after (week 13) and 12 weeks after the intervention (week 24), as compared to baseline. The second objective of this study was to examine whether this exercise plus GMCB intervention could improve participants' SRE, OE, enjoyment of physical activity and satisfaction with physical activity-related outcomes. It was hypothesized that participants would report improvements in these social cognitions, as compared to baseline values, at both 13 and 24 weeks. The third purpose of this study was to predict *independent* physical activity from the social cognitions outlined. It was hypothesized that SRE (including goal setting, planning and barriers efficacy), OE and satisfaction at six and 13 weeks would predict *independent* physical activity at 13 and 24 weeks, respectively. According to Rothman's model (2000), enjoyment should only predict physical activity at initiation and not long-term adherence. It was therefore hypothesized that enjoyment would not predict long-term physical activity at either week 13 or 24. Finally, the fourth objective of this study was to assess changes in obese

youths' body composition and strength. It was hypothesized that compared to baseline, participants would experience improvements in body composition and strength immediately post-intervention (week 13) and these improvements would continue to improve 12 weeks post-intervention (week 24).

Methods

Participants

In total, 50 obese adolescents completed the 12-week intervention ($M_{\text{age}} = 14.16$, 17 males, 71.4% Caucasian, $\text{mean}_{\% \text{body fat}} = 44.48$). Participants completed an average of 23 out of 27 exercise sessions (85% attendance rate). Twelve weeks later, 42 participants completed 24 week assessments ($M_{\text{age}} = 14.16$, 14 males, 74.4% Caucasian, $\text{mean}_{\% \text{body fat}} = 44.32$). See the REACH methods paper for inclusion and exclusion criteria (Wilson et al., 2009).

Measures

Measures were taken pre- (baseline), during (week 6), immediately post- (week 13) and 12 weeks post-intervention (week 24). It should be noted that in order to attain accurate 'baseline' measures for group cohesion, leader collaboration, SRE and satisfaction with the REACH programme, these social cognitions were assessed after participants had had some experience with the group and their leader. As such, baseline assessment for these measures was conducted at week 2. A brief overview of the measures pertinent to this study follows. Further details of these measures can be found in the methodology paper (Wilson et al., 2009).

Manipulation checks. In order to assess the extent to which the intervention was delivered as planned, several manipulation checks were implemented. Measures of group cohesion and leader collaboration were based on the original measures developed by Rejeski et al. (2003), and modified by Cramp and Brawley (2006)

and had acceptable levels of internal consistency in this study ($\alpha \geq 0.87$). Exercise intensity was recorded through minute-by-minute heart rate (Polar heart rate monitors), as well as through subjective measures of rating of perceived exertion (Robertson et al., 2005).

Independent physical activity. The seven-day physical activity recall interview (Blair, 1984) was used to measure volume of independent physical activity. Volume was calculated by summing the total number of minutes of moderate and vigorous physical activity participants engaged in each week.

Self-regulatory efficacy (SRE). Targeted aspects of SRE (goals, planning and barriers) were assessed using three separate measures developed by Cramp and Brawley (2006) for their GMCB exercise intervention, modified for the youth in this study. All SRE scales were scored on a 100% confidence scale, from 0% (*absolutely not confident*) to 100% (*absolutely confident*), in 10% increments. The mean of each SRE subtype's scale items was computed and used in subsequent analyses. Higher values indicate higher SRE. These measures had acceptable levels of internal consistency in this study ($\alpha \geq 0.78$).

Outcome expectations (OE). Participants' expectations that engaging in regular physical activity would lead to salient social, physical and psychological outcomes were assessed using a modified version of a previously published OE instrument (modified for youth from Rogers and Brawley, 1991). Specifically, four items were used to assess social OE (e.g. socialize with other kids similar to me), seven items were used to assess physical OE (e.g. help control my weight) and seven items were used to assess psychological OE (e.g. decrease stress). Participants were asked to rate the likelihood of each outcome occurring as a result of participating in physical activity over the next four weeks, with responses anchored on a nine-point Likert-type scale ranging from 1 (*very unlikely*) to 9 (*very*

likely). In this study, measures derived from each of these subscales were found to be internally consistent (Cronbach $\alpha \geq 0.83$).

From an SCT perspective, Bandura (1986) proposed that only those OE that are *valued* by participants (i.e. perceived as personally important) are likely to contribute to the prediction of salient outcomes for those participants. Thus, in this study, participants were asked to rate the value associated with each social, physical and psychological outcome described above on a nine-point Likert-type scale, with potential responses ranging from 1 (*little value to me*) to 9 (*high value to me*). Only those OEs that were endorsed as being highly valued (defined as a score of at least 5 (*average value to me*)) were included in the subsequent analyses. If three or more items (out of seven) for the physical and psychological OE subscales and two or more items (out of four) from the social OE subscale were not endorsed with a value ≥ 5 , data from that participant were not included in the subsequent analyses. As such, the means of all *valued* OE item responses, for each of the three subscales (social, physical, psychological) were calculated and used in the subsequent analyses. Higher values were indicative of higher OE.

Enjoyment. Participants' enjoyment of physical activity was assessed using the Physical Activity Enjoyment Scale (PACES; Kendzierski and DeCarlo, 1991). This scale has 18 Likert-type items and was used to assess enjoyment of the physical activity the participant had engaged in over the last week. Exercise enjoyment was computed by determining the scale average score. This measure had acceptable levels of internal consistency in this study ($\alpha \geq 0.95$).

Satisfaction. Participants' satisfaction was assessed using measures modified for children based on Jeffery and colleagues (2006). There were three categories of satisfaction assessed in this study: satisfaction with physical outcomes, satisfaction with current physical state and

satisfaction with changes resulting from the REACH programme. Participants were asked to rate how satisfied they were with the outcome described (eight for physical outcomes, five for current physical state and 11 for the REACH programme), for a total of 23 items, and respond on a nine-point Likert response scale, from -4 (*very unsatisfied*) to 4 (*very satisfied*). These measures had satisfactory levels of internal consistency in this study ($\alpha \geq 0.73$).

Percent body fat, lean mass and percent android fat. Body composition was measured by dual-energy x-ray absorptiometry (DXA; General Electric-Lunar iDXA, Ames Medical). For the purposes of this study, total percent body fat, lean mass and android fat were obtained. DXA scans have been found to be reliable in children (Gutin et al., 1996) and sensitive to changes from physical training (Gutin et al., 1995).

Strength. Isometric strength was assessed using a strain gauge manometer connected to the leg press and chest press HUR (Helsinki University Research) machines. Three maximum voluntary contractions (MVC) were performed of three to five second duration for the right leg and arm with a one-minute rest between each contraction. The maximal value was recorded as participants' peak power. Participants were provided visual feedback of the force, and verbal encouragement (Gandevia, 2001). Strength values of the peak MVC were used for analyses.

Statistical analyses

Data were analysed using PASW Statistics (v18.0, 2010). Changes in outcome variables and manipulation checks were analysed using one-way repeated measures analysis of covariance (RMANCOVA; drug and exercise condition entered as covariates). Bonferroni corrections were used to correct for multiple tests. Significant main effects for time were followed up with pairwise comparisons. Linear regression analysis

was used to predict physical activity at weeks 13 and 24 from social cognitions at weeks 6 and 13, respectively.

Results

Manipulation checks

Exercise intensity. Data collected using minute-by-minute heart rate and self-reported RPE confirmed that all participants exercised *at least* at a moderate intensity during each training session ($M\%HRR = 53$, $SE = 2.04$; $MRPE = 6.35$, $SE = 0.29$).

Group cohesion and leader collaboration. After controlling for exercise intensity, there was a significant main effect for time for GMCB leader collaboration, $F(1, 42) = 6.37$, $p < .05$. While the main effects for time for group cohesion and exercise leader collaboration did not reach standard levels of significance ($ps > .05$), comparison of means indicated group cohesion and exercise leader collaboration were relatively high at both week 2 ($M_{cohesion} = 4.01$, $SD = 0.71$; $M_{exercise\ leader\ collaboration} = 4.36$, $SD = 0.53$) and week 13 ($M_{cohesion} = 4.15$, $SE = 0.72$; $SD = 0.58$; $M_{exercise\ leader\ collaboration} = 4.40$, $SD = 0.55$). Means for cohesion and both types of collaboration were greater than 4.15 after the final GMCB session (13 week assessment), indicating that participants 'agreed' or 'strongly agreed' that they were part of a cohesive group and had developed collaborative relationships with the GMCB session and exercise leaders.

Primary objective

Physical activity. After controlling for exercise intensity and drug condition, consistent with our hypothesis, a significant main effect for time was found for volume of physical activity, $F(2, 36) = 15.51$, $p < .001$, $\eta^2 = .46$. Pairwise comparisons indicated that there were significant differences in physical activity between baseline and both 13 and 24 weeks, $ps < .001$,

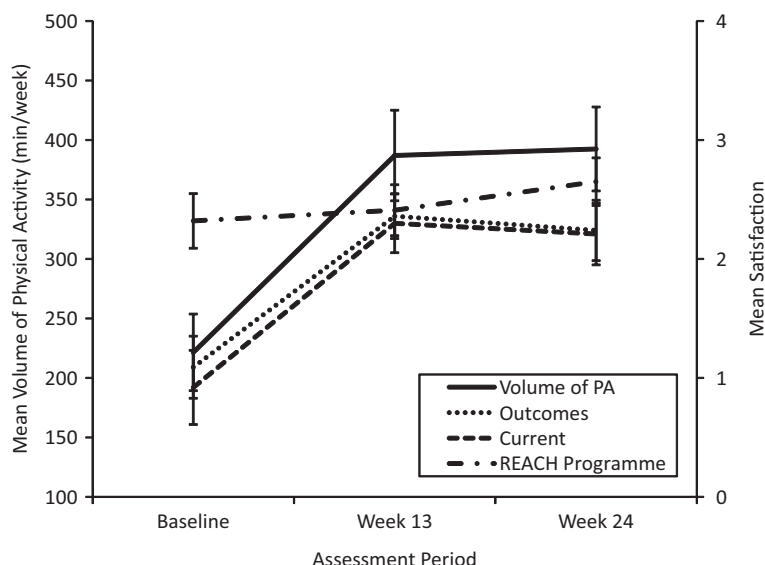


Figure 2. Mean volume of physical activity (min/week) and satisfaction at baseline, weeks 13 and 24. Error bars represent standard error.

Notes:

PA = physical activity, outcomes = satisfaction with outcomes, current = satisfaction with current physical state, and REACH programme = satisfaction with outcomes from the REACH programme.

*Significant difference between baseline and week 13 for volume of PA, satisfaction with outcomes and current physical state, $ps < .01$.

**Significant difference between baseline and week 24 for volume of PA, satisfaction with outcomes and current physical state, $ps < .01$.

and no difference in physical activity between week 13 and 24, $p > .05$. Figure 2 displays these findings.

Secondary objective

Self-regulatory efficacy (SRE). After controlling for exercise intensity, as hypothesized, significant main effects for time were found for all three types of SRE, $F_s \geq 3.84$, $ps < .05$, $\eta^2s \geq .20$. Pairwise comparisons indicated that there were significant increases in barrier self-efficacy between baseline and 13 weeks, and significant increases in goal setting, planning and barrier self-efficacy between baseline and 24 weeks, $ps < .05$. Means and standard deviations can be found in Table 1.

Outcome expectations (OE). After controlling for exercise intensity, consistent with our

hypothesis, initially high OE remained high and did not change at 13 or 24 weeks, $F_s \geq 2.24$, $ps \geq .12$. Means and standard deviations are reported in Table 1.

Satisfaction. After controlling for exercise intensity, as hypothesized there were significant main effects for time for satisfaction with physical outcomes and current physical state, $F_s \geq 13.33$, $ps < .001$, $\eta^2s \geq .33$. Satisfaction with the REACH programme was assessed at week 2. Initially high satisfaction ($M_{\text{baseline}} = 2.32$, range -4 to 4) with the REACH programme remained high and did not differ at week 13 ($M_{\text{week 13}} = 2.41$), or 24 ($M_{\text{week 24}} = 2.65$), $F = 0.99$, $p = .38$. Pairwise comparisons indicated that there were significant increases in satisfaction with physical outcomes and current state from baseline to weeks 13 and 24, $ps < .001$. Figure 2 displays these findings.

Table 1. Outcome variables at baseline, weeks 13 and 24

Variable	Baseline	Week 13	Week 24
	M (SD)	M (SD)	M (SD)
SE – Goal-setting	68.94 (16.26)	72.19 (16.88)	79.17 (17.08)*
SE – Planning	71.65 (20.79)	78.10 (17.00)	82.29 (16.87)*
SE – Barriers	64.96 (19.34)	71.86 (19.48)*	73.55 (17.93)*
OE – Social	6.28 (2.40)	6.63 (2.05)	6.83 (1.51)
OE – Physical	7.81 (1.21)	7.96 (0.91)	7.99 (0.76)
OE – Psychological	7.30 (1.86)	7.87 (1.14)	7.66 (1.16)
Enjoyment	4.47 (1.18)	5.54 (1.07)***	6.03 (0.95)***
% Body fat	45.74 (5.09)	44.44 (5.08)***	44.26 (5.69)***
Lean mass	48.60 (10.38)	49.27 (10.14)	49.50 (10.31)
% Android fat	57.74 (5.29)	56.24 (5.22)**	54.50 (9.70)**
Chest strength (N/m)	107.78 (32.34)	114.98 (30.78)**	119.40 (44.06)**
Leg strength (N/m)	124.58 (50.93)	153.63 (55.66)**	143.54 (56.79)

Notes: SE = Self-efficacy; OE = Outcome expectations; SE was measured on a 0 (*absolutely not confident*) to 100% (*absolutely confident*) scale. OE were measured on a 1 (*very unlikely*) to 9 (*very likely*) scale. Enjoyment was measured on a 1 (*I hate it*) to 7 (*I enjoy it*) scale.

* $p < .05$; ** $p < .01$; *** $p < .001$ for differences compared to baseline.

Enjoyment. After controlling for exercise intensity, as hypothesized, there was a significant main effect for time for enjoyment of physical activity, $F(2, 32) = 33.97, p < .001, \eta^2 = .68$. Pairwise comparisons indicated that enjoyment of physical activity was significantly greater at both weeks 13 and 24 as compared to baseline, $ps < .001$. Means and standard deviations can be found in Table 1.

Third objective

Separate linear regression analyses predicting physical activity at weeks 13 and 24 from social cognitions at weeks 6 and 13 respectively, revealed that 19% of the variance in week 24 physical activity could be accounted for by week 13 satisfaction, $R^2 = .19, p = .07$. Specifically, two of the three components of satisfaction contributed to the prediction of physical activity; lower satisfaction with current physical state ($\beta = -0.45, p = .07$) and higher satisfaction with outcomes from the REACH programme ($\beta = 0.45, p = .07$). Satisfaction with outcomes did not contribute

to the prediction of physical activity ($\beta = 0.05, p = .88$).

Fourth objective

Percent body fat, lean mass and percent android fat. After controlling for exercise intensity and drug condition, there were significant main effects for time for percent body fat and percent android fat, $F_s \geq 7.55, p < .01, \eta^2 = .29$. Increases in lean muscle mass were not significant, $F(2, 38) = 0.60, p = .55, \eta^2 = .03$. Pairwise comparisons revealed that there were significant improvements in percent body fat and android fat between baseline and both 13 and 24 weeks, $ps < .05$. Means and standard deviations can be found in Table 1.

Strength. After controlling for exercise intensity, there were significant main effects for time for both chest, and leg strength, $F_s \geq 4.18, ps < .05, \eta^2 \geq .13$. Pairwise comparisons indicated increases were significant between baseline and 13 weeks for chest and leg strength, $ps < .01$; and between baseline and 24 weeks for chest

strength, $p < .01$. Means and standard deviations can be found in Table 1.

Discussion

Findings from the present study represent advancement in theory-based physical activity interventions for obese youth. Specifically, the findings that immediately post- and 12 weeks post-intervention participants engaged in a greater amount of *independent* self-reported physical activity as compared to baseline provide preliminary support for the feasibility of a GMCB and exercise intervention model for obese youth. These findings are consistent with previous GMCB interventions for cardiac patients (Rejeski et al., 2003), elderly adults (Brawley et al., 2000) and post-natal women (Cramp and Brawley, 2006), such that participants in the exercise plus GMCB condition engaged in significantly more independent physical activity at follow-up as compared to those in the standard exercise programme.

Examination of the social cognitions assessed in this study can offer potential reasons as to why this intervention may have helped obese adolescents engage in more independent physical activity after intervention completion. For example, participants reported increases in all forms of SRE (i.e. goal setting, barrier and planning) over time as compared to baseline. Participants were repeatedly given the opportunity to master goal-setting, plan and overcome barriers to physical activity, and in accordance with social cognitive theory, confidence to engage in these skills increased (Bandura, 1986). Enhancements in SRE may be considered particularly positive because previous research has shown that SRE partially mediates physical activity behaviour in adolescent girls (Dishman et al., 2004) and in post-natal women (Cramp and Brawley, 2009). SRE has also been found to predict future health behaviours (Rovniak et al., 2002; Woodgate et al., 2005). However, contrary to this previous research, SRE did not predict future physical

activity behaviour in this study. Unlike adults, obese youths' motives to engage in physical activity may be less influenced by regulating physical activity, and more by salient *proximal* outcomes (e.g. satisfaction with weight loss). It is conceivable that youth, who have less formal demands on their time than adults, are less restricted by efficacious beliefs surrounding self-regulation.

Furthermore, the findings that OE remained high immediately post- and 12 weeks post-intervention could be interpreted to mean that the intervention was successful at helping participants feel they were achieving social, physical and psychological outcomes. In line with social cognitive theory (Bandura, 1986) and as Rothman (2000) suggests, if people achieve the outcomes they expected to when they set out to change their behaviour, they are likely to feel satisfied with their persistence for the newly acquired behaviour. Furthermore, satisfaction with outcomes from previous efforts could influence decisions to continue such behaviours, and ultimately influence long-term healthy lifestyle choices. However, in the current study, OE did not predict independent physical activity. One possible explanation is that OEs are better able to predict more proximal behaviour (i.e. days), as opposed to six to 12 weeks in this study.

Enjoyment of physical activity and satisfaction with outcomes and current physical state were higher at both weeks 12 and 24. Furthermore, satisfaction at the end of the intervention (week 13) accounted for 19% of the variance in physical activity at week 24. These findings are consistent with and extend Rothman's (2000) previous research on enjoyment and satisfaction. Interestingly, results from the regression indicated that lower current state satisfaction and higher satisfaction with outcomes from the REACH programme predicted independent physical activity. One way to interpret these findings is that lower satisfaction with current physical state initially motivated participants to act in order to become more satisfied with their bodies, and because

participants felt satisfied with the proximal outcomes they had achieved through the REACH programme (i.e. engaging in regular physical activity), they chose to continue an active lifestyle in order to continue to incur positive outcomes. This interpretation fits with social cognitive theory (Bandura, 1989), which suggests that there is a triadic reciprocal relationship between cognitions, the environment and behaviours. One way that future adolescent obesity interventions may help participants feel satisfied with their efforts could be to include components that encourage participants to reflect regularly on the achievements they have made during the programme. For example, through the GMCB approach, participants regularly set, work towards and reflect on physical activity goals. In this process the GMCB sessions may help participants focus on the progress they are making, thus helping them feel satisfied with their efforts.

Our findings that participants reported enjoying physical activity more over the course of the intervention should be viewed positively in the obesity treatment literature. Indeed, Ekkekakis and Lind (2006) found that overweight women reported significantly lower pleasure when the exercise intensity was 10% higher than participants would have self-selected. Understanding why participants in this study, who were exercising at a moderate to vigorous intensity, reported *greater* enjoyment in physical activity throughout the programme is worthy of future study. However, one possible explanation could be that participants may have perceived the exercise sessions as more enjoyable by exercising in a cohesive and supportive environment (Carron et al., 1996).

Similar to self-efficacy and OE, enjoyment of physical activity did not predict physical activity immediately post or 12 weeks post-intervention. This finding is in line with social cognitive theory (Bandura, 1986) and Rothman's (2000) model of exercise adherence, such that exercise enjoyment may be critical at the beginning of the programme, but does not account for keeping participants in the programme or

engaging in independent physical activity post-intervention.

There are several strengths of this study. This intervention was theoretically driven, using aspects of social cognitive theory (Bandura, 1986) and group dynamics (Carron et al., 1996; Cartwright, 1951; Cartwright and Zander, 1953) that have been associated with exercise adherence (Burke et al., 2005; Carron et al., 1996; Spink and Carron, 1993). Social cognitions amenable to change were assessed at critical time points consistent with planned progress for their development during the intensive phase of the intervention. Another strength of the study was the 12-week post-intervention (week 24) assessment of physical activity, as this allowed for the examination of independent physical activity maintenance effects. The use of intervention manipulation checks to examine the social context of the intervention was another important strength of the study as this confirmed that we were successful in attaining the specific social environment we aimed to create (i.e. cohesive and collaborative).

Despite these strengths, several limitations deserve attention. Most notably, given that this was a feasibility study, a control group was not included. This lack of comparison group does not allow us to conclude definitively that the positive changes witnessed were due solely to the exercise plus GMCB intervention. Furthermore, other components of the REACH intervention not reported in this study (e.g. sessions with the dietician and social worker) may have impacted the obese adolescents' health behaviours (e.g. physical activity and dietary behaviours) and corresponding outcomes (e.g. social cognitions, body composition). Another limitation was the use of self-reported physical activity data. It would have been ideal to substantiate the subjective physical activity data with objective assessments of physical activity through use of technology such as accelerometers. It should be noted, however, that participants demonstrated significant improvements in both body composition and strength at both weeks 13 and 24.

Improvements in these anthropometric measures support the subjective physical activity data as it is highly unlikely that such improvements would have been made without engaging in more physical activity as compared to when they started the programme.

In conclusion, the present findings provide preliminary evidence that an exercise plus GMCB intervention can be an effective treatment option for obese youth. Participants engaged in more independent physical activity immediately post and 12 weeks post-intervention, reported increases in SRE, enjoyment and satisfaction as well as maintenance of OE and experienced improvements in body composition and fitness. This study is the first to provide theory-based evidence that GMCB interventions can have favourable effects on physical activity and associated outcomes in this population. A logical future area of study is to conduct a large randomized control trial that compares a GMCB plus exercise condition for obese adolescents with a control condition, consisting of an attention control plus exercise. Such a trial would provide robust evidence for the effect the GMCB intervention has on physical activity as well as elucidate which social cognitions the intervention specifically changes. Furthermore, based on our findings it is suggested that satisfaction with outcomes, current state and changes resulting from the intervention could be properly explored as possible mediators of change. If a link between satisfaction and physical activity is established, research exploring how to enhance feelings of satisfaction in this population would be warranted. Such research could begin with focus groups involving obese adolescents and establish criteria that this population deems to be important to feel satisfied with.

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Competing Interests

None declared.

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Appendix: Intervention

Specific details of the procedures used in this intervention have been published in a methods paper (Wilson et al., 2009). A brief overview of the intervention components that are relevant to the current study is provided below.

Exercise programme

All participants engaged in the 12-week exercise programme which consisted of a warm-up, aerobic exercises (e.g. treadmill, stationary bikes, steppers and rowers), strength training (e.g. resistance exercises for all the major muscle groups) and a cool down. Exercises were performed at *either* a moderate or a vigorous intensity for the entire 12 weeks (depending on group assignment; see Fig. 1). In order to deter dependence on the group (and increasingly encourage independent self-regulation), the exercise sessions were progressively less frequent (i.e. 1 hour, 3x/week for weeks 1–6; 1 hour, 2x/week for weeks 7–9; and 1 hour 1x/

week for weeks 10–12). For more details of the exercise programme please see the REACH methods paper (Wilson et al., 2009).

Group-mediated cognitive-behavioural sessions (GMCB)

For the first 12 weeks of the intervention, participants engaged in weekly group behaviour change sessions. These sessions were delivered in a group setting, and are based on the GMCB intervention model (Brawley et al., 2000). For more details of the GMCB intervention, please see the REACH methods paper (Wilson et al., 2009).