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A GROᴜP-MEDIATED COGNITIVE-BEHAVIOURAL EXERCISE INTERVENTION FOR OBESE ADOLESCENTS: EFFECTS OF EXERCISE INTENSITY ON INDEPENDENT PHYSICAL ACTIVITY, SOCIAL COGNITIONS, BODY COMPOSITION AND FITNESS

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A GROUP-MEDIATED COGNITIVE-BEHAVIOURAL EXERCISE INTERVENTION FOR OBESE ADOLESCENTS: EFFECTS OF EXERCISE INTENSITY ON INDEPENDENT PHYSICAL ACTIVITY, SOCIAL COGNITIONS, BODY COMPOSITION AND FITNESS

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Abstract

This study sought to examine the effects of a group-mediated cognitive-behavioural (GMCB) plus moderate or vigorous intensity exercise intervention on obese adolescent's independent physical activity, social cognitions, body composition and fitness. Based on social cognitive theory and group dynamics, weekly GMCB sessions were designed to foster self-regulatory skills to engage in regular physical activity after intervention completion. Thirty-one obese adolescents (female = 19, BMI ≥ 95^{th} percentile; 10-16 years of age) were randomly assigned to either moderate (HRR = 40-55%) or vigorous (HRR = 60-75%) supervised 12-week exercise training conditions. Outcomes were assessed at baseline, 6-, 13-weeks and 6-months. Regardless of exercise condition, participants engaged in more physical activity at 13-weeks and 6-months. Social cognitions and fitness improved similarly or were maintained for all participants regardless of exercise condition. These findings suggest that an exercise program enhanced with GMCB sessions can result in favourable outcomes in the treatment of childhood obesity.

Keywords: childhood obesity, physical activity, exercise intensity, group-mediated cognitive-behavioural, satisfaction, enjoyment, self-efficacy, outcome expectations, fitness, body composition

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Chapter 1: Literature Review

Introduction

Childhood obesity has become an epidemic in developed countries worldwide (World Health Organization, 2000). A recent health report by Statistics Canada indicated that 26% of Canadian youth were overweight or obese (Shields, 2006). In line with global trends, the prevalence of childhood obesity in Canada has tripled over the last 3 decades, from 3% in 1978 to 9% in 2004 (Merrifield, 2007). The main factors contributing to the etiology of obesity are diet, physical inactivity, and metabolic factors (Weinsier, Hunter, Heini, Goran, & Sell, 1998). The prevalence of childhood obesity is of concern because of the connection between childhood obesity and type 2 diabetes, cardiovascular disease, psychosocial problems (e.g., depression and low self-esteem) and adult obesity (Deckelbaum & Williams, 2001; Freedman, Khan, Dietz, Srinivasan, & Berenson, 2001; Gungor, Thompson, Sutton-Tyrrell, Janosky, & Arslanian, 2005). Furthermore, the cost of treating these largely preventable (Malina, 2001; Tuomilehto et al., 2001), debilitating diseases associated with childhood obesity is immense (Birmingham, Muller, Palepu, Spinelli, & Anis, 1999). Thus, the development of effective treatment initiatives aimed to help obese youth adopt and *maintain* healthy lifestyles is prudent. Given the correlation between childhood obesity and chronic diseases (Gungor et al., 2005; Pulkki-Raback et al., 2009), such treatment initiatives could have a positive impact on population well-being and reduction in health care costs.

The treatment of childhood obesity has been approached through a variety of disciplines. Interventions for treating childhood obesity have included lifestyle (e.g., physical activity, dietary, and behaviour modification programs), medication (e.g., Orlistat, Metformin, Rimonabant) and surgery (e.g., bariatric surgery; Oude Luttikhuis et al., 2009). Such programs have reported varying degrees of success in achieving desired outcomes including improvements in body composition and fitness, and decreases in risk factors for cardiovascular disease (Oude Luttikhuis et al., 2009).

In a recent Cochrane review of childhood obesity interventions, Oude Luttikhuis and colleagues (2009) examined the utility of a wide range of treatment options. Medication in combination with lifestyle intervention for obese youth was found to result in greater improvements in BMI as compared to placebo with lifestyle interventions (Oude Luttikhuis et al., 2009). Unfortunately, some adverse side effects have been associated with medication, including gastrointestinal upset (e.g., increased defecation, cramps and abdominal pain), renal and cardiovascular abnormalities. Bariatric surgery has recently become a treatment option for obese adolescents. While this is an extremely expensive and invasive option, there is preliminary evidence suggesting that bariatric surgery (specifically laparoscopic adjustable gastric banding) may be an effective treatment option for extremely obese adolescents (O'Brien et al., 2010).

Oude Luttikhuis and colleagues (2009) reported that dietary interventions, such as low glycemic index diets and teaching obese youth to choose healthy foods, resulted in improved body mass index (BMI) and fat mass in the short-term (i.e., 3 months). Improvements in body composition were maintained at 12-month follow-up for obese youth who had been taught how to choose healthy foods. In addition, Oude Luttikhuis et al. reported some beneficial effects on body composition at 6-month follow-up for interventions focusing on getting obese youth physically active. Of note, most physical activity interventions reviewed did not involve a comprehensive exercise program, but rather focused primarily on teaching participants what exercise opportunities existed in their community (e.g., soccer games, walking with pedometers). Of most practical relevance, the use of behavioural strategies (e.g., goal setting, self-monitoring) to teach healthy lifestyle choices (i.e., nutrition and physical activity) led to improvements in BMI that persisted at 12 months for obese adolescents (Oude Luttikhuis et al., 2009).

In summary, there are a variety of treatment approaches for childhood obesity that have achieved varying degrees of success. It seems logical to suggest that for long-term health, individuals need to have the knowledge and skills to consistently make healthy lifestyle choices. Furthermore, given the cost and the potential side effects of medication and surgery, lifestyle modification may be a more appropriate first step in the treatment of childhood obesity. Starting with modifiable behaviours that reliably impact risk factors is essential, thus physical activity and nutrition are key areas for intervention. Weinsier et al. (1998) has suggested that while diet is important, individuals cannot be on long-term calorie-restricted diets. Therefore, empowering individuals to engage in regular physical activity has the potential to effectively help obese adolescents lose weight and gain additional health benefits (Weinsier et al., 1998).

Role of Exercise in the Treatment of Obesity

'Best practice' guidelines for the treatment of childhood obesity were recently published based on an amalgamation of the literature (Flynn et al., 2006). This synthesis suggested that current lifestyle-focused childhood obesity interventions, which attempt to change health behaviours in obese children, lead to short-term improvements in outcomes (e.g., BMI, biological factors), and do not appear to lead to any adverse effects (Flynn et al., 2006). Increasing obese children's physical activity level emerged as an essential component of effective childhood obesity treatment programs for inducing and maintaining weight loss. The Public Health Agency of Canada suggests that youth should accumulate at least 90 minutes of moderate or vigorous physical activity per day, and decrease the amount of time spent being sedentary (i.e., decreasing TV screen time) by at least 90 minutes per day (Janssen, 2007; Sithole & Veugelers, 2008). Disappointingly, Statistics Canada (2008) found that only 48.7% of Canadian children engaged in at least 30 minutes of physical activity per day. While past studies have examined the effects of decreasing sedentary behaviours versus increasing physical activity on obese youth's BMI (Epstein, Myers, Raynor, & Saelens, 1998), the critical component in any successful weight loss program is to ensure that more calories are expended than ingested (Atlantis, Barnes, & Singh, 2006; Blair & Church, 2004). Physical activity can be an effective way to help obese youth achieve this calorie expenditure (Atlantis et al., 2006; LeMura & Maziekas, 2002; Trost, Kerr, Ward, & Pate, 2001).

Encouraging obese youth to engage in regular physical activity also has other benefits: physical activity has been found to improve overall health and well-being (Blair & Church, 2004) and cardiovascular fitness (Gutin et al., 2002). Interestingly, a recent meta-analysis reported that of the obesity treatment studies analyzed, all prescribed less than the amount of exercise that is recommended for health benefits by the International Association for the Study of Obesity (IASO; i.e., at least 30-60 minutes per day at a moderate intensity of both aerobic and resistance exercises; Daniels et al., 2005; Saris et al., 2003), yet were still able to improve body composition in obese youth (Atlantis et al., 2006). Taken together, these findings suggest that any increases in physical activity would be of benefit for obese adolescents.

Recently, a correlational study found that vigorous physical activity was associated with lower percent body fat and higher aerobic fitness in adolescents as compared to those engaging in lower intensities of physical activity (Gutin et al., 2002). Despite this finding, Gutin and colleagues (2002) suggested that obese adolescents should start with moderate exercise until they can do longer bouts of vigorous exercise for two reasons; 1) objectively assessed "moderate" activity could actually be perceived as quite difficult for sedentary obese adolescents, and 2) vigorous intensity activity may result in obese adolescents doing less activity the following day. Unfortunately, the effectiveness of moderate intensity exercise on improving obese adolescent's body composition is unclear, as Daley et al. (2006) found that moderate intensity exercise (40-59% heart rate reserve [HRR]) did not have an effect on body composition as assessed by BMI.

Further, there is little empirical evidence to suggest that vigorous activity results in obese children being less active the next day.

In another examination of exercise intensity in obese youth, Gutin, Yin, Humphries and Barbeau (2005) examined moderate intensity (55-60% VO_2 max) compared to vigorous intensity (75-80% VO_2 max) circuit training (aerobic and resistance exercise) combined with lifestyle education. The inclusion of resistance exercise in Gutin and colleagues' trial was an advancement in the field, as recent exercise prescription recommendations by the IASO suggest that obese youth should engage in cardiovascular exercise combined with resistance training for the greatest improvements in body fat compared to only cardiovascular exercise (Daniels et al., 2005; LeMura & Maziekas, 2002). No differences in improvements in the obese youth's body composition or fitness were found between the moderate and vigorous intensity exercise conditions. However, as noted by the authors, the obese participants did not exercise in the high intensity exercise zone consistently, thus the validity of the null finding is questionable. It is plausible that, had the participants in the vigorous intensity condition spent a greater proportion of their exercise training at a vigorous level, greater improvements in body composition and fitness would have been accrued as compared to those in the moderate intensity condition.

Currently, the evidence remains controversial regarding the best exercise intensity for this population and their weight loss goals (Atlantis et al., 2006; Gutin et al., 2005; LeMura & Maziekas, 2002). Future studies are warranted examining the effects of higher volumes and intensities of exercise on obese adolescent's body composition. Further, it may be of relevance to delineate the effects of moderate or vigorous intensity exercise on psychosocial factors, such as how enjoyable moderate or vigorous intensity exercise is, what outcomes an obese child expects to gain from such exercise, and how satisfied one is with the outcomes of a moderate or vigorous exercise program. It seems plausible that these psychosocial factors could in turn influence adherence to an exercise program. However, this leaves a number of outstanding questions in the literature. Could there, for instance, be a relationship between exercise intensity and satisfaction with exercise outcomes or enjoyment of physical activity? If such relationships existed, and were positive, could satisfaction with exercise outcomes or enjoyment of physical activity act as mediators in the relationship between exercise intensity and adherence to physical activity? Examples of social cognitions related to participation in physical activity may be instructive.

Physical Activity and Social Cognitions

Outcome expectancies. Social cognitions play an integral role in initiating and maintaining a new behaviour, as detailed in a recent model by Rothman (2000). For instance, expectations regarding outcomes of engaging in a new behaviour, have been suggested to play an essential role in exercise behaviour (Rothman, 2000). Individuals who expect positive results from a behaviour are more likely to engage in the behaviour given that they also have requisite self-efficacy (Social-cognitive theory; Bandura, 1997).

For example, Gao, Hannon and Yi (2007) found that outcome expectations were significant positive predictors of university students' physical activity behaviour. Cramp and Brawley (2006) reported that compared to standard care, postpartum women in an exercise intervention combined with self-regulatory skills sessions reported maintained high outcome expectations immediately after the exercise program and at 1-month follow-up. Yet to be determined is whether a physical activity intervention designed to maintain high outcome expectations could subsequently lead to higher levels of long-term (i.e., 6 months) independent physical activity after intervention completion. Specifically, it is possible that if the positive outcomes obese adolescents' anticipate achieving from a weight loss program are met, they will feel satisfied, which could translate into long-term adherence to healthy lifestyle behaviours.

Satisfaction. Rothman (2000) suggested that an individual's cognitive appraisal of satisfaction with outcomes from previous efforts plays an important role in adherence to the behaviour. This suggestion also falls in line with social cognitive theory, as this theory describes individuals as active agents in making behavioural choices (Bandura, 1986). Therefore, past behaviours that have resulted in satisfying outcomes are likely to be continued. Satisfaction has been assessed previously in a school-based Lifestyle Education for Activity Program (LEAP; Dishman et al., 2004), which aimed to increase adolescent girls' physical activity using a social cognitive theory framework. The adolescent female's outcome expectancy value and satisfaction with current physical activity positively predicted physical activity behaviour (Dishman et al., 2004). The strongest relationship was between satisfaction and physical activity at 2-year follow-up (Dishman et al., 2004). Similarly, Finch and colleagues (2005) found that among overweight adults in a weight-loss program, weight loss was associated with positive outcome expectations and satisfaction.

The role of satisfaction with outcomes was recently examined in a longitudinal weight loss study for adults (Jeffery, Linde, Finch, Rothman, & King, 2006). Three-hundred and thirty-one participants engaged in a diet and exercise counseling weight loss intervention. Participants were randomized into one of two experimental conditions: comparing outcomes the participants' experienced with expectations of ideal outcomes (i.e., future-focused, how much weight participants want to lose); or comparing experienced outcomes with their status before treatment (i.e., past-focused, how much success participants had achieved). The future-focused group was told that focusing on the positive benefits of achieving their ideal weight loss goal was the key to sustaining their motivation; whereas the past-focused group was told to focus on positive outcomes from their new healthy behaviours, as compared to before they were engaged in such behaviours. The purpose of the experimental conditions was an attempt to manipulate participant's satisfaction with their weight loss progress, current weight status, and changes resulting from the program. Overall, satisfaction with weight loss progress decreased over time for both experimental conditions and no differences between the conditions were found. Satisfaction with their current weight status and changes resulting from the program were not different over time or between groups. It is possible that different strategies may be more effective at manipulating satisfaction and could be explored. For example, a more intense exercise program could result in greater changes in body composition and fitness, which in turn could lead to greater satisfaction with such outcomes.

While this study did not find satisfaction to be related to treatment outcomes, Jeffery (2006) suggested that satisfaction may play a stronger role in long-term behaviour adherence, as compared to behaviour initiation; such that individuals who are more satisfied with changes resulting from their efforts will be more likely to maintain their behaviours. Thus, in a childhood obesity intervention, participant's satisfaction may be important for long-term physical activity adherence. It is plausible to suggest that individuals are satisfied with outcomes when they work hard enough to achieve measurable results. However, it is yet to be explored if obese adolescents can actually *enjoy* exercise that is hard enough to result in maintenance of positive outcome expectations and satisfaction with outcomes. Enjoyment is considered next.

Enjoyment. Exercise enjoyment has increasingly been recognized as an important factor influencing participation in physical activity (Ekkekakis, Hall, & Petruzzello, 2008; Ekkekakis & Lind, 2006; Motl, Dishman, Saunders, & Dowda, 2001) and exercise adherence (Johnson & Heller, 1998; Wankel, 1993). It is posited that if individuals think that they will enjoy engaging in the behaviour, they will be more likely to do it. Given the importance of exercise in helping obese adolescents lose weight and improve their health, examination of factors that affect exercise enjoyment in this population is necessary. In the past, studies have found that higher intensity exercise was associated with lower pleasure (Ekkekakis et al., 2008) and enjoyment (Treasure & Newberry, 1998). Individuals engaging in vigorous intensity exercise may perceive they will have greater weight loss as compared to individuals engaging in moderate intensity exercise. In spite of this, moderate intensity exercise may be perceived as more enjoyable in this population. On the other hand, individuals may enjoy it more if they see results faster.

The assessment of outcome expectations, enjoyment and satisfaction with outcomes could provide useful information regarding cognitions that may influence obese adolescent's independent physical activity behaviour. Factors that impact these social cognitions, such as exercise intensity, may also interact to influence long-term physical activity adherence. Examination of these social cognitions and exercise intensity on independent physical activity is an important area of future research.

Future Directions for Physical Activity Interventions in Obese Adolescents

Identification of factors that are related to obese adolescents' physical activity behaviour will fill important gaps in the obesity intervention literature (Baranowski, Lin, Wetter, Resnicow, & Hearn, 1997; Epstein et al., 1998; Flynn et al., 2006; Marcus et al., 2000). Specifically, exploring strategies that help obese adolescent's engage in regular physical activity is a fundamental area of concern. It has been suggested that self-regulatory skills are integral for an individual to regularly engage in independent physical activity (Bandura, 1991). Thus, while it is important to teach obese adolescents *how* to exercise, resulting in immediate benefits from physical activity, researchers must also empower obese adolescents with the skills to *maintain* a healthy lifestyle after the intervention concludes. Teaching these youth self-regulatory skills (e.g., self-monitoring, goal setting) pertinent for physical activity behaviour is one feasible strategy for doing so. Furthermore, enhancing our understanding of psychosocial factors that influence adherence to physical activity behaviour of obese adolescents *after a program has ended* will provide useful information. Researchers have begun to explore some of these factors with varying degrees of success.

Methodological and design issues. Interestingly, while many studies noted the significant psychosocial issues facing obese children in past interventions, the majority of these behaviour change studies have not reported the effects of the treatment on psychosocial variables (Flynn et al., 2006). Flynn and colleagues recommended that any psychosocial variables targeted in interventions should be assessed before, during, and after treatment. The timing of such assessments is essential to accurately elucidate the mechanisms that moderate and/or mediate the long-term effectiveness of childhood obesity treatment programs (i.e., psychosocial, environmental, program factors; Epstein et al., 1998; Flynn et al., 2006; Wilfley et al., 2007). Furthermore, rigorous experimental designs should be implemented to assess outcome variables.

Unfortunately, previous childhood obesity treatment studies have been lacking in methodological quality. For example, two separate reviews both concluded that the majority of behaviour change interventions designed for obese children have not described or implemented adequate blinding and/or concealment techniques (Atlantis et al., 2006; Epstein et al., 1998; Flynn et al., 2006). In addition, detailed measures of program adherence have generally not been explained in previous childhood obesity interventions (Flynn et al., 2006). Participant adherence to a program, including compliance with exercise intensity and attendance at exercise sessions, could have meaningful implications for interpreting treatment outcomes.

Similarly, quality of intervention implementation could influence results. For example, previous studies have not included methodological details on the lifestyle intervention protocol implemented, training of the interventionist, facilities utilized, or specific exercise protocols used (Atlantis et al., 2006; O'Brien et al., 2010). Failing to provide such information diminishes the ability for other researchers to critically evaluate results, replicate study findings, or improve upon the intervention. Future studies need to consider the effects of program adherence and quality of the implementation of the intervention on treatment outcomes (Atlantis et al., 2006; Epstein et al., 1998; Flynn et al., 2006).

Another important area of methodological improvement that needs to be made in childhood obesity interventions is the use of superior measures of body composition (i.e., fat distribution, abdominal fat, measures that account for changes in height; Atlantis et al., 2006; Epstein et al., 1998; Flynn et al., 2006) than have been previously used. The majority of childhood obesity interventions thus far have based weight loss outcomes on simple assessments of BMI. More accurate measures of body composition in youth are necessary because BMI does not adequately represent percent body fat, particularly in obese youth (Dao et al., 2004).

Theoretical foundation issues. Apart from use, and adequate timing of appropriate measures, interventions aimed at reducing weight in obese children should ensure that the intervention itself is sufficient to induce changes in weight-related outcomes. In a seminal paper discussing behaviour change research, Baranowski and colleagues (1997) suggested steps researchers should take to develop a stronger foundation on which to build future interventions. First, researchers need to demonstrate that their behaviour change intervention leads to changes in the anticipated mediator(s), and second, that the mediator(s) lead to changes in the outcome behaviour. Establishing these links is essential if researchers are to confidently conclude that any changes in the outcome behaviour were due to the intervention techniques implemented. If future interventions are to be developed that make significant improvements in behaviour, researchers must learn how to *create* such changes. In other words, we need to know how best to target the mechanisms of change.

In addition to the development of interventions that effectively target mediators of behaviour change, Baranowski and colleagues (1997) suggested three areas of future work; 1) the development of better (i.e., more specific, theory-based) tools to measure psychosocial variables, 2) improvement of techniques that interventions use to target mediating variables, and 3) measurement of constructs as specified by a theory that considers behaviour change. Through refinement of past interventions, future research will be able to identify predictors of behaviour change that reliably influence the behaviour, enhancing the success of such interventions (Brawley, 1993).

To further enhance the effectiveness of interventions targeting social cognitions to elicit changes in physical activity behaviour, it is imperative that such studies interpret and report their results based on the constructs assessed. As an example, Trost and colleagues (1999) examined social cognitive correlates of objectively assessed physical activity behaviour in youth. The authors concluded that interventions aiming to increase children's physical activity should target physical activity self-efficacy (also known as task self-efficacy for physical activity) to increase physical activity. However, what the researchers actually assessed in their study was children's confidence to overcome *barriers* to physical activity (i.e., self-regulatory efficacy). Targeting barrier self-efficacy requires an intervention plan quite unique from an intervention aimed at increasing task-related physical activity self-efficacy.

Efforts to curb the growing trend of childhood obesity call for improvements in childhood obesity interventions. Among the many recommendations made, several are feasible with meticulous intervention planning. Specifically, these feasible recommendations are as follows. First, it is important to include accurate and timely measures thought to be associated with weight loss in children. Second, rigorous experimental designs must be implemented detailing critical aspects of the intervention such as blinding and concealment, adherence to the intervention and intervention fidelity. Third and finally, interventions will be more effective and efficient if they are designed utilizing a guiding framework that specifies which constructs to target that are hypothesized to alter behaviour and when such constructs may have their greatest impact on important variables (i.e., outcomes such as adherence or mediators such as self-regulatory efficacy). The importance of this last recommendation cannot be understated. The choice of theory for intervention requires a strong scientific and practical rationale. The background supporting this point is briefly provided next.

Importance of Theory-based Interventions

A theory is composed of interrelated constructs and delineates relations between such constructs to allow the prediction and explanation of behaviour (Kerlinger, 1986). Ideally, theories are testable and are applicable to a variety of behaviours and situations (Brawley, 1993; Glanz & Rimer, 1995). Theories are highly practical because they provide an evidence-based starting point for interventions (Brawley, 1993).

Theory-based interventions are essential because they provide a framework as to which constructs to target and when (Baranowski et al., 1997; Brawley, 1993). In doing so, researchers are able to determine potential mechanisms through which the intervention is working (Glanz, Rimer, & Lewis, 2002). For example, theories of behaviour suggest that psychosocial factors, such as self-efficacy and social support, play an important role in modifying an individual's health behaviour. Using theory as a guide, the appropriate timing and techniques of assessing such psychosocial factors are outlined (Glanz et al., 2002). Through proper assessments, meaningful findings regarding the moderating and/or mediating role of psychological factors are elucidated;

enhancing our understanding about *why* and *how* a behaviour change did or did not occur (Brawley, 1993; Glanz et al., 2002).

When theory is not used in the development of an intervention, variables may not be targeted strategically. Therefore, if the intervention does not work, researchers are not able to offer a tenable rationale as to why the intervention failed (Brawley, 1993). Additional benefits of theory-based interventions include the ability to identify specific aspects of the intervention that worked, and aspects that need improvement. Future studies are then able to focus on variables that are proven to be effective moderators or mediators of change, thus potentially shortening the intervention and making it more cost effective (Glanz et al., 2002). Through this process, theory guides practice and the lessons learned from practice modify theory (Brawley, 1993; Cialdini, 1980). The first step in planning an intervention is choosing the appropriate theory to guide it.

Several characteristics of theories are important to consider in choosing a framework for a health behaviour change intervention. First, to change physical activity behaviour, the theory chosen must target *alterable* predictors of physical activity initiation and adherence (Brawley, 1993). For example, the theory of planned behaviour (Ajzen, 1985) and self-efficacy theory (Bandura, 1982) include constructs pertaining to one's attitude and self-confidence, respectively; both of which have repeatedly been shown to be malleable and related to exercise behaviour.

Second, the theory chosen to induce changes in a health behaviour intervention should acknowledge that the variables can change over time through social learning (Brawley, 1993) in a reciprocal nature (Maddux, 1993). Therefore, specific intervention techniques are appropriate at different phases of the intervention. Third, the assessment of variables over time can provide insight into the independent and mediating roles of variables that specifically influence behaviour initiation and maintenance of health behaviours (Brawley, 1993). Collectively, these characteristics are essential for researchers to consider while choosing an appropriate theory to use and guide the development of a health behaviour change intervention.

Social Cognitive Theory: Applications in Interventions for Obese Adolescents

One of the most influential theories of health behaviour change is social cognitive theory (Bandura, 1986). Social cognitive theory describes human behaviour as an interaction between the individual, behaviour and environment, wherein individuals contribute to and are products of social systems (Bandura, 2001). Individuals are described as 'active agents' in making decisions about their behaviours. This means that individuals are capable of the development of intentions and forethought, self-reflection about and self-regulation of behaviours (Bandura, 2001). A key component in this model is self-efficacy, which is an individual's confidence in one's abilities to effectively engage in goal-related actions to achieve desired goals (Bandura, 1982). Social cognitive theory posits that an individual's self-efficacy influences one's behaviour, cognitions and affect, which in turn, influence the individual's self-efficacy. For example, individuals are more likely to engage in physical activity (behaviour) if they are confident that they can do the behaviour (self-efficacy), and perceive that they will experience positive affect (or a reduction in negative affect) from doing physical activity. Furthermore, individuals' motivation, perseverance, initiation and maintenance of behaviour are influenced by their self-efficacy (Strecher, DeVellis, Becker, & Rosenstock, 1986). Together, social cognitions are posited to play an integral role in an individuals' behaviour (Bandura, 1986).

Social cognitive theory has been used in a variety of domains to understand, predict and change health behaviours (Bandura, 2004), including: smoking cessation (Van Zundert, Nijhof, & Engels, 2009; Zheng et al., 2007); cancer prevention and treatment (Rogers et al., 2005); diet (Hickey, Reynolds, Hinton, & Shewchuck, 1999); and physical activity (Anderson, Wojcik, Winett, & Williams, 2006; Jung & Brawley, in press-a, in press-b). Constructs within social cognitive theory have been used to prospectively predict physical activity in a diverse group of adults (Anderson et al., 2006). Use of self-regulatory strategies, self-efficacy and social support explained 46% of the variance in adults' physical activity, with use of self-regulatory strategies acting as the strongest predictor of physical activity (Anderson et al., 2006). Based on these findings, it was suggested that self-regulatory strategies play an important role in physical activity behaviour and could be a focus in future physical activity interventions (Anderson et al., 2006).

Previous childhood obesity studies have applied social cognitive theory in the school setting (Caballero et al., 2003; Robinson, 1999; Robinson et al., 2003; Sharma, 2006; Stevens et al., 2003; Warren, Henry, Lightowler, Bradshaw, &

Perwaiz, 2003). These school-based interventions have primarily focused on preventing obesity through increasing children's physical activity levels during and after school hours, improving their eating behaviours and nutrition knowledge (e.g., eating more fruits and vegetables, proper serving sizes), and decreasing television and video game use. For example, Robinson (1999) conducted a social cognitive theory-based intervention in schools aimed to reduce television, videotape and video game use and examined the effects on changes in adiposity, physical activity and diet. Teachers taught 18 lessons of 30-50 minutes duration covering topics such as self-monitoring videotape and video game use, and goal setting (e.g., aspiring to view a maximum of 7 hours per week). Children in the treatment group had significantly greater decreases in BMI and other obesity measures as compared to those in the control group. The findings from this social cognitive theory-based intervention suggest that the techniques used (i.e., self-monitoring and goal setting) may have been useful in helping children view less television, and may have consequently resulted in improvements in the intervention participant's BMI.

As outlined by social cognitive theory (Bandura, 1986), the environment can influence an individual's behaviour through a number of facets; including social support and opportunities for observational learning experiences to enhance efficacious beliefs. In recognition of the importance of the environment on youth eating behaviours, Golan and Weizman (2001) developed an interesting framework to help guide childhood obesity nutrition interventions. In this framework, the parents (as opposed to the child) are targeted as the agent of change for treating childhood obesity. Parents are taught how to empower their children to make decisions about what and how much to eat, and to offer a variety of foods; all of which are aimed at creating a healthy home environment. Drawing from social cognitive theory, concepts such as modeling are used to help children make healthier choices. For example, the parents are taught to eat healthfully (i.e., quantity, types of foods), thus setting a positive example for their children to learn from. In addition, through making the home environment healthier, it is theorized that it will be easier for children to make and maintain healthy nutrition choices (Golan & Weizman, 2001).

A recent review of similar social cognitive theory school-based interventions, which targeted self-monitoring (Robinson et al., 2003; Steckler et al., 2003) and self-efficacy (Robinson et al., 1999; Warren et al., 2003), reported that such interventions have typically found modest changes in health behaviours, with variable effects on obesity (Caballero et al., 2003; Robinson, 1999; Robinson et al., 2003; Sharma, 2006; Steckler et al., 2003; Warren et al., 2003). Unfortunately, while these studies have *targeted* theory-derived behavioural skills (e.g., self-monitoring) and psychological variables (e.g., self-efficacy), the majority of these studies have not assessed *changes* in the targeted constructs (Sharma, 2006). Inline with other reviews of the childhood obesity literature (i.e., Epstein et al., 1998), Sharma recommended that all health and behavioural variables be assessed before, during and after the intervention. In addition to providing the potential identification of process variables that mediated and/or moderated behaviour change and outcome change, such assessments would allow researchers the possibility of providing explanation should outcome variables not be influenced by the intervention.

The broad range of behaviours social cognitive theory has been applied to in childhood obesity interventions have included sedentary screen time (Robinson, 1999), before and after-school physical activity (Caballero et al., 2003), nutrition knowledge and parent's eating behaviours (Golan & Weizman, 2001), all with varying degrees of success. Given the literature that supports the utility of social cognitive theory for behaviour change interventions (Anderson et al., 2006; Bandura, 2004; Hickey et al., 1999; Rogers et al., 2005; Van Zundert et al., 2009; Zheng et al., 2007), it would be beneficial to use social cognitive theory to develop an effective intervention for obese youth that specifically targets psychological variables known to influence behaviours associated with obesity, and explore their mediating potential. Such an intervention would focus on the child and his or her behaviour (e.g., physical activity, nutrition), behaviour modification skills (e.g., self-regulation) as well as the child's environment (e.g., the child's family environment) in order to help the child make healthy lifestyle changes. While a handful of childhood obesity studies have measured psychological variables, few have successfully targeted them in the intervention and examined their mechanistic role on obesity parameters. More research is necessary to further elucidate mechanisms of behaviour change in this population.

Behaviour Modification

Childhood obesity treatment programs that involve behaviour modification techniques have been found to be superior in achieving weight loss and maintenance to those not teaching such techniques (Epstein & Wing, 1987; Epstein, Wing, Koeske, Andrasik, & Ossip, 1981; Wisotsky & Swencionis, 2003). The first study to demonstrate this examined the effectiveness of either teaching parents and their obese children behaviour modification skills (e.g., contingency contracts, self-monitoring, social reinforcement) or nutrition education (e.g., label reading, low-calorie meal recipes; Epstein et al., 1981). Parents and children assigned to a behaviour modification group had superior relative weight change as compared to those in the nutrition education group (Epstein et al., 1981). Since this seminal study, research in childhood obesity has continued to examine the utility of behaviour modification. A more recent review found that despite considerable methodological limitations in previous studies, behavioural and cognitive behavioural modification strategies combined with diet and physical activity changes aided in decreasing adolescent obesity in the short term (i.e., less than 1 year; Atlantis et al., 2006; Tsiros, Sinn, Coates, Howe, & Buckley, 2008). The long-term effects (2 or more years follow-up) of cognitive behavioural strategies on obese youth's behaviour remain to be demonstrated (Tsiros et al., 2008).

According to social cognitive theory, self-regulatory skills play an important role in making behavioural changes and maintaining a healthy lifestyle (Anderson, Winett, & Wojcik, 2007; Bandura, 1991). Self-regulation involves monitoring one's behaviour, comparing one's behaviour to set goals or criteria (i.e., evaluation/feedback) and changing the behaviour to meet the set goals (Anderson et al., 2007). There are many types of behaviour modification strategies that can be used, including cognitive strategies (e.g., planning; goal-setting), behavioural strategies (e.g., self-monitoring) and cognitive-behavioural strategies (e.g., contingency management).

The main goal of childhood obesity interventions is to help participants lose weight. Research has demonstrated that interventions aimed to help obese children make healthy lifestyle changes have been able to achieve weight loss in the short term (i.e., less than 1 year; Epstein, Paluch, Roemmich, & Beecher, 2007; Wilfley, Stein et al., 2007; Wilfley, Tibbs et al., 2007) and there is some evidence to suggest they achieve long-term (i.e., 5-10 years) weight loss as well (Epstein et al., 2007). In order for participants to sustain their weight loss, it is essential for obesity treatment programs to teach participants skills to *maintain* their newfound healthy behaviours. The underlying processes in making and maintaining such lifestyle changes is the ability to self-regulate health behaviours, part of which involves the competence to consciously make healthy choices (i.e., engage in regular physical activity and healthy eating; Bandura, 1991).

In translating the evidence from successful studies to interventions, a challenge is to find some means of delivering self-regulatory skill learning and practice to participants in an environment that facilitates the experience and motivates participants. One possibility that may hold both research and practice promise is the use of a group as an agent of change delivery format (Brawley, Rejeski, & Lutes, 2000).

The Group as an Agent of Change

When developing an intervention program for obese youth that aims to foster *maintenance* of health behaviour changes, it is important to consider the setting in which to teach self-regulation skills. Numerous studies have found that cohesive groups lead to greater adherence to a physical activity program (Carron & Burke, 2005; Carron, Hausenblas, & Mack, 1996; Estabrooks, 2000). Indeed, Carron and colleague's (1996) meta-analysis reported that exercise classes with significantly higher participation rates were characterized by high levels of participant-reported task or social cohesion. In addition, Carron and colleagues found that task-cohesive groups had almost twice the social influence on adherence behaviour as compared to family support. Since individuals in cohesive groups are more likely to adhere to exercise programs, it is suggested that establishing such a positive learning environment may be an underlying mechanism that motivates and enhances learning of behaviour change skills (i.e., self-monitoring and goal setting), thus acting as a *facilitating agent of behaviour change* (Brawley et al., 2000; Carron et al., 1996; Cartright, 1951).

In the childhood obesity treatment literature, behavioural skills taught in a group format have been just as effective at instilling weight loss as when taught to participants individually (Epstein & Wing, 1987). Considering that the group format is more cost-effective, teaching self-regulation skills through group sessions could be an efficient mode of delivery. Given that adolescents typically have a strong desire to 'fit in' (Steinberg & Silverberg, 1986), there may be additional benefits of teaching self-regulation skills through a group format. Finally, compared to their normal weight peers, obese adolescents have typically reported significantly lower quality of life (Deckelbaum & Williams, 2001) and self-esteem (French et al., 1996); thus the social support fostered through a group-based obesity intervention may be particularly beneficial for obese adolescents.

Group-Mediated Cognitive-Behavioural Interventions (GMCB)

Brawley and colleagues (2000) developed the group-mediated cognitive-behavioural (GMCB) model, which aims to facilitate learning of self-regulation skills, grounded in social cognitive theory, through using the group as an agent of change. Typically delivered in weekly sessions, the first aim is to develop a cohesive group. This is achieved through the participants deciding on a name for the 'team' as well as a team cheer (Brawley et al., 2000). After informing the participants that they are more likely to be successful in making behaviour changes because they are part of a team, the next goal is to help participants become aware of their current behaviour through self-monitoring. The participants monitor their physical activity behaviour for a short period of time (e.g., a week), and then discuss with the group how their current behaviour compares to the amount of physical activity recommended to accrue health benefits. The participants then set a specific individual goal and a combined group goal to increase their physical activity over the next week. Over the course of the rest of the sessions (typically 8-12 weeks total), the group sessions revolve around discussing behaviours from the past week, self-regulatory skills they tried (what worked and what did not), and helping support group members in achieving independent and group goals of being more physically active. Other topics of discussion include developing solutions to overcome barriers to physical activity, rewards to motivate themselves, outcome expectations, mastering skills to self-regulate regular physical activity, and methods to achieve set goals. The GMCB model suggests gradually tapering the structured exercise sessions off and increasingly relying on independent self-regulation of physical activity to teach participants to be active without the help of the intervention staff (Brawley et al., 2000).

GMCB interventions are based on social cognitive theory (Bandura, 1986) and the group dynamics literature (Carron et al., 1996; Cartwright, 1951; Cartwright & Zander, 1953). Social cognitive theory is used as the theoretical framework because it suggests that to increase adherence to a behaviour, it is critical to change an individual's cognitions and the skills necessary to change the behaviour(s) which generally concern 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 & Brawley, 1991). Furthermore, the self-regulatory skills taught within GMCB are in line with social cognitive theory (Bandura, 1986). Drawing from group dynamics theory, Brawley and colleagues (2000) suggested the group should be developed to "use its social pressure, motivation and support to encourage members to adopt the cognitive-behavioural changes (p. 50)".

Recently, separate studies involving postnatal women (Cramp & Brawley, 2006), elderly adults (Brawley et al., 2000) and cardiac rehabilitation patients (Focht, Brawley, Rejeski, & Ambrosius, 2004; Rejeski et al., 2003) implemented GMCB interventions and reported positive adherence with their respective exercise programs. These GMCB interventions led to greater improvements in frequency of exercise (Brawley et al., 2003; Cramp & Brawley, 2006; Rejeski et al., 2003), long-term adherence (Brawley et al., 2003; Cramp & Brawley, 2006; Rejeski et al., 2003), fitness (Rejeski et al., 2003), self-efficacy for mobility (Rejeski et al., 2003), barrier self-efficacy (Cramp & Brawley, 2006) and health related quality of life in elderly women (Focht et al., 2004) as compared to those in control groups. Collectively, GMCB interventions are thought to be effective because they facilitate learning self-regulatory skills through a cohesive and supportive group environment, which encourages participants to make and maintain healthy lifestyle changes.

Self-efficacy targeted in GMCB interventions. Self-efficacy, a key construct within social cognitive theory, is one of the most commonly cited variables that can play a role in health behaviour change (Bandura, 1982). Self-efficacy is an individual's confidence in his or her ability to organize and perform actions in order to achieve a specific outcome (Bandura, 1982). Numerous studies support the role of self-efficacy in making health behaviour changes (Anderson et al., 2007; Foley et al., 2008; Linde, Rothman, Baldwin, & Jeffery, 2006; Trost et al., 2003). In children specifically, both task efficacy and barrier efficacy have been reported as the strongest predictors of physical activity behaviour (Foley et al., 2008; Trost et al., 2001; Trost et al., 2003). Children's self-efficacy to overcome barriers to physical activity has also been shown to be correlated with objectively measured physical activity (Trost et al., 1999). Further, results from the Lifestyle Education for Activity Program (LEAP) suggest that general exercise self-efficacy (items addressed a range of factors influencing confidence to exercise, such as barriers to assessments of social support) is at least a partial mediator in physical activity levels among adolescent girls (Dishman et al., 2004).

The most common methods used to foster self-efficacy include mastery (i.e., allow the individual to master progressively more challenging skills), modeling (i.e., watch an expert demonstrate the skill), verbal persuasion (i.e., verbal encouragement – 'You can do it!') and physiological arousal (i.e., awareness of feelings evoked from engaging in the behaviour). Individuals who engage in vigorous intensity exercise, for example, should have higher exercise self-efficacy for engaging in vigorous exercise than those who only engage in moderate intensity exercise, because they will have had the chance to "master" higher intensity exercise. The physiological arousal experienced by individuals who engage in vigorous intensity exercise should also contribute to their greater exercise self-efficacy for vigorous exercise as compared to those who never experience such high intensity exercise.

In a GMCB physical activity intervention, task efficacy (i.e., physical activity self-efficacy, confidence to engage in a specific physical activity for a specific duration, intensity and frequency) and the range of efficacy for self-regulatory skills is targeted: goal setting (confidence to set goals to be physically active), barrier (confidence to overcome barriers to physical activity) and planning (confidence to plan and schedule physical activity into daily life). Through the GMCB sessions and weekly homework assignments, participants practice the skills that lead to increases in task efficacy and self-regulatory (i.e., goal setting, barrier and planning) efficacy. Task efficacy is developed as participants engage in various intensities of physical activity, working up to engaging in a greater frequency and duration of physical activity. Goal setting self-efficacy is developed as participants practice setting goals to be physically active. As the participants master their goals, they are taught to set progressively more challenging goals. Barrier self-efficacy is developed as the group discusses barriers preventing the participants from engaging in physical activity and helps each individual develop strategies to overcome such barriers. Finally, planning self-efficacy is developed as participants learn how to plan physical activity into their daily lives. These techniques are consistent with the four sources of self-efficacy as outlined in social cognitive theory (Bandura, 1977) and accordingly, increasing self-efficacy is a central component of a GMCB physical activity intervention.

Previous GMCB physical activity studies have examined a number of factors associated with and/or impacted by the GMCB physical activity intervention including: a global index of life satisfaction (Brawley et al., 2000), health related quality of life (Focht et al., 2004); physical activity efficacy (Rejeski et al., 2003); barrier and self-regulatory efficacy (Cramp & Brawley, 2006); proximal outcome expectations (Cramp & Brawley, 2006); MET level (aerobic fitness; Focht et al., 2004); and physical activity adherence (Brawley et al., 2000; Cramp & Brawley, 2006; Rejeski et al., 2003). These factors have been assessed in healthy older adults (Brawley et al., 2000), cardiac rehabilitation patients (Focht et al., 2004; Rejeski et al., 2003) and post-partum women (Cramp & Brawley, 2006); and have been found to either increase or be maintained for participants in the GMCB condition as compared to control comparison conditions. In addition, self-regulatory efficacy has been found to partially mediate the relationship between exercise condition and post intervention independent physical activity (Cramp & Brawley, 2009).

Taken together, findings from studies that have utilized the GMCB model suggest potential mechanisms through which the GMCB intervention helps individuals engage in independent physical activity. Furthermore, these findings provide evidence to support theoretical propositions with respect to which psychosocial variables are reliably related to independent physical activity, and thus should be targeted in future interventions.

Identification and assessment of psychosocial constructs related to physical activity behaviour in obese adolescents that have not been examined in previous GMCB interventions could be a valuable addition to the GMCB and childhood obesity treatment literature. For example, as previously discussed, enjoyment and satisfaction are two psychosocial constructs that hold promise for influencing independent physical activity and have not yet been exclusively examined in obese adolescents. The GMCB model would posit that changes (or maintenance) in psychosocial cognitions affected by the GMCB sessions play an important role in determining independent physical activity after the intervention concludes.

The REACH Intervention: An Overview

The intervention discussed in this thesis was part of a larger, multidisciplinary childhood obesity treatment program in association with The London Children's Hospital and London Health Sciences Centre. The REACH intervention began with an intensive 12-week exercise plus GMCB program. Participants were randomized into either a moderate or vigorous intensity exercise condition. Participants in both conditions engaged in aerobic and resistance training, and participated in identical weekly GMCB sessions. Following the intensive 12-week intervention, participants continued in the 2-year REACH program, including a metformin/placebo intervention, weekly exercise sessions at a local community centre for 1.75 years, family sessions with a dietitian and a social worker, and comprehensive medical monitoring. The present study has focused on the intensive 12-week exercise plus GMCB intervention during the first 12 weeks of the program and includes a 6-month assessment of independent physical activity.

Chapter 2: The Current Study

Study Goals and Objectives

Previous studies utilizing the GMCB model have demonstrated substantial improvements in long-term (6 months) frequency and volume of independent physical activity as compared to standard exercise interventions (Brawley et al., 2000; Cramp & Brawley, 2006; Rejeski et al., 2003). These studies have also observed increases and maintenance of outcome expectations and aspects of self-regulatory efficacy (Cramp & Brawley, 2006; Rejeski et al., 2003), psychosocial cognitions that a GMCB intervention aims to influence. What has yet to be established is the role of exercise intensity on physical activity behaviour in GMCB interventions, and whether exercise intensity influences psychosocial cognitions imperative for short and long-term physical activity adherence.

Primary Objective

The main objective of this study was to compare the effects of a moderate-intensity exercise plus GMCB intervention to a vigorous-intensity exercise plus GMCB intervention on obese adolescent's independent physical activity (i.e., weekly energy expenditure, frequency, duration and volume) immediately following the 12-week intervention and at 6-month follow-up.

Secondary Objectives

There were four secondary objectives of the present study. The first objective was to examine the effects of moderate or vigorous intensity exercise on participant's social cognitions pertaining to independent physical activity while engaging in a GMCB intervention. Specifically, differences between conditions on self-regulatory and physical activity self-efficacy, outcome expectations, enjoyment of physical activity and satisfaction (i.e., satisfaction with outcomes, current state and outcomes from the REACH program) were explored. The second objective was to examine the effects of a moderate or vigorous 12-week exercise program on obese adolescent's body composition and fitness (i.e., strength and aerobic fitness). The third objective was to assess whether physical activity, barrier, goal setting and planning self-efficacy, outcome expectations, enjoyment, or satisfaction predicted independent physical activity (i.e., volume of physical activity). The fourth objective was to assess whether residual change in enjoyment or satisfaction mediated the relationship between exercise intensity and volume of independent physical activity at 6-month follow-up.

Hypotheses

Primary Hypothesis

1. Participants in the vigorous condition were expected to engage in more independent physical activity (i.e., weekly energy expenditure, frequency, duration and volume) compared to participants in the moderate condition at both 13-week and 6-month follow-ups. The rationale for this hypothesis was based on the predicted differential effects of moderate or vigorous exercise on social cognitions (see hypotheses 2-5).

Secondary Hypotheses

2. Given that mastery experience is one of the strongest sources of self-efficacy, participants who have a chance to master an activity (i.e., set goals and

achieve them, vigorous physical activity for the vigorous group) should report higher self-efficacy for that specific activity. Therefore, because participants in both the moderate and vigorous conditions practiced using self-regulatory skills through the GMCB sessions, it was hypothesized that goal setting, planning and barrier self-efficacy would increase to the same extent in both exercise conditions. However, it was hypothesized that compared to participants in the moderate condition, participants in the vigorous condition would report higher self-efficacy to engage in vigorous physical activity at 13-weeks.

3. Moderate and vigorous exercise were hypothesized to differentially affect social, physical and psychological outcome expectations. Although participants were intentionally concealed from the exercise condition they were in, it is logical to suggest that participants in the vigorous condition felt they were exercising at a challenging intensity; whereas participants in the moderate condition may have felt they were not working at a high intensity. Based on this assumption, it was hypothesized that participants in the vigorous condition would report higher physical outcome expectations at 13-weeks as compared to those in the moderate condition. In contrast, it may have been easier for participants to socialize in the moderate condition and the exercise sessions may have felt more psychologically rewarding for this condition, thus it was hypothesized that participants in the moderate condition would report higher social and psychological outcome expectations for participating in physical activity at 13-weeks.

4. Based on the wealth of literature that suggests moderate intensity exercise is more enjoyable (Ekkekakis et al., 2008; Ekkekakis & Lind, 2006; Motl, et al., 2001), it was hypothesized that participants in the moderate condition would report higher exercise enjoyment at 13-weeks as compared to participants in the vigorous condition.

5. Because participants in the vigorous condition were expected to push themselves at a more intense level, it was thought that participants in the vigorous condition would perceive they were achieving more benefits from working at a high intensity as compared to participants in the moderate conditions. Therefore, at 13-weeks, satisfaction with outcomes, satisfaction with their current physical state (e.g., "the way clothes look and feel on me") and satisfaction with outcomes from the REACH program were expected to be greater for participants in the vigorous condition as compared to participants in the moderate condition.

6. Given that numerous studies have found improvements in obese adolescent's body composition and fitness following aerobic and resistance training, it was hypothesized that all participants would see improvements in their body composition, strength and aerobic fitness at 13-week follow-up. However, because the vigorous condition engaged in higher intensity exercise and should have expended more total calories, it was predicted that participants in the vigorous condition would have greater improvements in body composition as compared to those in the moderate condition. In addition, participants in the

vigorous condition were expected to have greater improvements in strength and aerobic fitness as compared to those in the moderate condition.

7. Given the evidence suggesting there is a positive relationship between self-efficacy, outcome expectations, enjoyment and satisfaction with physical activity, it was hypothesized that regardless of exercise condition, higher values of these psychosocial variables at 6-, and 13-weeks would predict higher volume of physical activity (i.e., minutes of physical activity per week) at 13-weeks and 6-months respectively.

8. Furthermore, it was hypothesized that residual change scores from baseline to 13-weeks for enjoyment and satisfaction would mediate the relationship between exercise intensity and 6-month volume of physical activity. Given that the intensity of the exercise component of the intervention was hypothesized to specifically manipulate enjoyment and satisfaction, only these two psychosocial variables were examined as potential mediators of the exercise condition and 6-month behaviour relationship.

Method

Design

This study was approved by The University of Western Ontario Research Ethics Board (REB # 15590). Informed consent was obtained from all participants and their parent/guardian. Participants were randomized to engage in either a moderate or vigorous intensity 12-week supervised exercise program involving both aerobic and resistance training at the Exercise and Health Psychology Laboratory and Laboratory for Brain and Heart Health at The University of

Western Ontario. Randomization was completed via a computer-generated randomized numbers table. The REACH study coordinator was responsible for enrolling participants and group assignment. Exercise condition allocation was concealed from the participants. Exercise leaders were aware of exercise condition assignment out of necessity to instruct participants to engage in the assigned level of intensity. Assessments were conducted pre-(baseline), during (2- and 6-weeks), and post-intervention (13-weeks and 6-months).

Participants

Participants were 31 obese adolescents (*M*age = 14.13; *M*BMI = 33.34; 65% female) recruited via local pediatricians' referrals, newspaper and radio advertisements and posters in public centres. Participants were eligible to participate if they were between the ages of 10 to 16 years, lived within 30 kilometer radius of London, Ontario, were classified as obese (BMI greater than the 95th percentile for their age and gender) and had no contraindications to exercise. Exclusion criteria included contraindications to exercise, inability to engage in group activities or discussions, or the inability to comprehend questionnaires (i.e., at least a grade 6 English learning level).

Sample Size

The sample size was predetermined based on the larger, multidisciplinary study of which this thesis was a part, and its outcomes. It was determined that REACH needed 30 patients per medication group (metformin or placebo), calculated to have an 80% power of detecting a difference of 1.5 kg/m^2 in BMI, assuming an alpha of 0.05, and a standard deviation of 2. Allowing for a 20%

drop out rate, it was determined that 72 participants were needed. Participants went through the REACH program in four waves. At the time of writing this thesis, 31 participants had completed 6-month assessments, 19 participants were in the 12-week intensive exercise program, and another 22 participants were being recruited for the final wave of this study. Sample size calculations were not performed for the first intensive 12 weeks of this study because the student researcher had no control over recruitment and timing.

Procedure

Screening, Baseline, 2-, 6-, 13-week and 6-month Assessments

Screening visit. During the initial screening visit, the parent and child met with a social worker at the London Children's Hospital who explained the details of the study and what was expected from the family. The social worker assessed both child and parent motivation (i.e., both indicated were interested in participating in the program and wanted to make changes), and established parental commitment to be their child's 'coach' (i.e., social support for making healthy lifestyle changes) for the entire program. Participants and their guardian then completed informed consent and were scheduled for the baseline assessment.

Baseline assessments. All assessments took place at the Exercise and Health Psychology Laboratory and the Laboratory for Brain and Heart Health at The University of Western Ontario and occurred before the 12-week intensive exercise program began. Assessors were trained graduate students and senior undergraduate students. Randomization occurred after this assessment.

Therefore, at baseline, all assessors were blinded to participants' exercise condition assignment. Participants were asked to wear exercise clothing and sturdy exercise shoes for the assessment. Assessments were completed in the following order: physical activity recall interview, psychosocial questionnaire package (outcome expectations, enjoyment and satisfaction), body composition via dual-energy x-ray absorptiometry (DXA), upper and lower body strength via isometric maximum voluntary contractions, and aerobic fitness via the modified Balke VO_2 max test. Testing took approximately 1.5 hours to complete at baseline; 30 minutes for physical activity recall interview and questionnaires, 15 minutes for body composition, 15 minutes for the strength tests, 20 minutes for the aerobic fitness test and 5 minutes for cool-down.

2-, 6-, 13-week and 6-month Progress Assessments. In order to avoid over or under reporting, some psychosocial constructs require that the participant have a chance to either engage in the behaviour or interact with the group before initial assessment (Carron & Brawley, 2000; McAuley & Mihalko, 1998). As such, participants completed "baseline" assessments of self-efficacy, satisfaction with outcomes from the REACH program, group cohesion and collaboration at the end of week 2 of the intervention.

The full array of psychosocial questionnaires, consisting of self-efficacy, outcome expectations, satisfaction and enjoyment measures, was re-administered at the 6- and 13-week and 6-month assessments. Group cohesion and collaboration were only re-administered at the 13-week assessment. In addition, at the 13-week and 6-month assessment participants also completed the 7-day physical activity recall, fitness (aerobic and strength) and body composition assessments. For the purposes of this thesis, only 7-day physical activity recall data are discussed from the 6-month assessment. A complete list of measures and assessment time points are summarized in Table 1.

To help participants monitor their progress, discuss motivation and continue to set challenging goals for themselves, "progress report cards" were given at the 13-week and 6-month assessments to discuss their attendance, show participants changes in their body composition, strength and aerobic fitness (See Appendix C for a sample progress report and goal setting sheet).

Table 1

Summary of Measure Assessments

Measure	Assessment period				
	Baseline	2-weeks	6-weeks	13-weeks	6-months
Height	X			X	X
Weight	X			X	X
DXA	X			X	X
Aerobic fitness	X			X	X
Strength	X			X	X
7-day PAR	X			X	X
Self-efficacy		X	X	X	X
Outcome expectations	X		X	X	X
Enjoyment	X		X	X	X
Satisfaction	X		X	X	X
Group cohesion		X		X	
Leader collaboration		X		X	

Note. 7-day PAR = 7-day physical activity recall.

Measures

Manipulation Checks

Attendance. Participant's attendance to the exercise and GMCB program was recorded. Attendance was calculated by dividing the number of sessions the participant attended by the number of sessions scheduled. This number was then multiplied by 100 to obtain the percentage of sessions attended.

Exercise intensity manipulation checks.

Heart rate. In order to ensure participants were exercising at the correct intensity (moderate or vigorous) for their condition, all participants wore Polar Vantage XL (Polar Electro Oy, Kempele, Finland) heart rate monitors during the aerobic exercise sessions. The monitors recorded participants' minute-by-minute heart rate. Daily averages were based on at least 12 minutes of recorded heart rates. Heart rate data were only included from session seven onwards as the first six sessions participants were learning how to use the equipment properly. These first six sessions were also used to teach participants how to keep their heart rate at the right intensity for an extended period of time. Averages do not include warm-up and cool-down heart rates.

Rating of perceived exertion. The OMNI rating of perceived exertion (RPE) scale (Robertson et al., 2005) was used during the aerobic exercise portion of the study to ascertain participants' subjective ratings of how hard they felt they were working. The scale ranges from 0 (*not hard at all*) to 10 (*very very hard*). Participants in the moderate intensity group were asked to keep their effort intensity in between 4-6 on this scale, and the vigorous group between 7-9. Similar to heart rate data, RPE data were not recorded for the first six sessions. This scale has been found to be a reliable indicator of physical effort in children and has sound psychometric properties (Bar-Or & Rowland, 2004; Robertson et al., 2005).

GMCB process measures.

Group cohesion. This measure was based on the original measure developed by Rejeski et al. (2003), and modified by Cramp and Brawley (2006). One of the central tenants of GMCB interventions is that the group setting facilitates participants' learning of self-regulatory skills. This questionnaire was administered in order to assess if the group environment in both exercise conditions had obtained a strong level of group cohesion. This 7-item measure assessed groupness and task-related cohesion. A sample item is "The group members help keep everyone motivated to continue being physically active". Participants responded to questions on a 5-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Group cohesion was assessed by calculating the mean scale score. Higher values indicate higher group cohesion. Previous studies have found acceptable levels of internal consistency for this measure (Cramp & Brawley, 2006). In this study this scale had an acceptable level of internal consistency (see Table 2; Nunnally, 1978).

Table 2

Internal Consistency for Psychosocial Measures (Cronbach's alphas)

Scale	Baseline	2-week	6-week	13-week
Group cohesion		.89		.89
Exercise leader collaboration		.91		.92
GMCB leader collaboration		.90		.87
SE - physical activity				
Light intensity		.78	.96	.96
Moderate intensity		.93	.87	.93
Vigorous intensity		.92	.88	.87
SE - goals		.89	.94	.85
SE - planning		.91	.94	.93
SE - barriers		.88	.86	.92
Social OE	.92		.90	.79
Physical OE	.84		.91	.90
Psychological OE	.94		.94	.92
S - outcomes	.87		.84	.83
S - current	.73		.81	.76
S - REACH		.93	.93	.92
Enjoyment	.96	.95	.96	.97

Note. GMCB = Group-mediated cognitive-behavioural; SE = Self-efficacy; OE = Outcome expectations; S = Satisfaction.

Collaboration. This measure was based on the original measure developed by Rejeski et al. (2003), and modified by Cramp and Brawley (2006). In GMCB interventions it is also important to assess the collaboration between the group and the interventionist and the exercise leaders. A 6-item questionnaire was used to assess collaboration between the group and the GMCB session leader, and an 11-item questionnaire was developed and used to assess collaboration between the group and the exercise leaders. The questionnaire assessing collaboration with the exercise leader included the items asked in the GMCB session leader collaboration questionnaire, and also asked participants if they wanted to impress the leader, if their exercise leader was positive, motivating and had a fun attitude. A sample item for the GMCB session leader collaboration scale is "I feel our discussion leader wants to know about our opinions and values our opinions about fitting the skills we learned into our daily life", and for exercise session leader collaboration is "Our physical activity leader cares about my health and about my opinions for developing my own physical activity program". Collaboration was assessed by calculating the mean score for each scale. Responses for each item were on a 5-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Higher values indicate higher leader collaboration. Previous studies have found acceptable levels of internal consistency for GMCB leader collaboration (Cramp & Brawley, 2006). In this study this scale had an acceptable level of internal consistency (see Table 2; Nunnally, 1978).

Primary Outcome

Self-reported physical activity. Participants completed the interview version of the 7-day Physical Activity Recall (PAR; Blair, 1984) to assess how much physical activity (weekly energy expenditure, frequency, duration, and volume) participants engaged in over the past week. The interviewer asked participants about the activities they engaged in each day for the past 7 days during the morning, afternoon and evening. The participants were also asked to report how long they engaged in each activity, and what intensity it was (i.e., light, moderate, hard or very hard). Number of hours in bed was also recorded for the previous week. This information was used to calculate weekly energy expenditure (kcal/kg/week), frequency, duration and volume of physical activity as outlined by Sallis et al. (1985). Weekly energy expenditure was calculated using the following equation: (hours in bed x 1 MET) + (hours of light intensity physical activity x 1.5 METs) + (hours of moderate intensity physical activity x 4 METs) + (hours of hard intensity physical activity x 6 METs) + (hours of very hard intensity physical activity x 10 METs). Frequency was calculated by summing the number of days the participant engaged in at least 15 minutes of moderate and/or vigorous intensity physical activity, giving frequency of physical activity per week. In order to calculate duration, total minutes of physical activity for the week were added and divided by the frequency, giving mean duration of physical activity per day. Finally, volume was calculated by multiplying frequency by duration, resulting in volume of total minutes of physical activity per week. This questionnaire has been shown to have satisfactory test-retest reliability and has been validated by comparing with heart rate monitor records in adolescents (Sallis, Buono, Roby, Micale, & Nelson, 1993).

Secondary Outcomes

Psychosocial assessments. All measures that had not been previously validated with adolescents were pilot tested with 12 age-matched youth (10 girls, 2 boys) and adjusted accordingly. Previously validated measures were modified to use age-appropriate terminology when necessary. An assessor was present to answer any questions the participants had while completing the measures. All questionnaires may be viewed in Appendix B.

Self-efficacy. Recommendations by McAuley and Mihalko (1998) were followed to ensure accurate assessments of self-efficacy were attained. Specifically, several distinct domains were evaluated rather than using a generic measure, and each measure was assessed after the participant had been given an opportunity to try the behaviour (McAuley & Mihalko, 1998). In this study, physical activity self-efficacy for light, moderate and vigorous intensity physical activity, and targeted aspects of self-regulatory efficacy (goal setting, planning and barrier) were assessed using measures based on those developed by McAuley and Mihalko (1998; physical activity self-efficacy), Garcia and King (1991; barrier self-efficacy), Poag-DuCharme and Brawley (1993; planning self-efficacy) and Rejeski et al. (2003; goal setting self-efficacy). All self-efficacy scales were scored on a 100 percent confidence scale, from 0 percent (*Absolutely Not Confident*) to 100 percent (*Absolutely Confident*), in 10 percent increments. Self-efficacy was computed by averaging the scale's items. Higher values indicate higher self-efficacy.

Physical activity self-efficacy. The purpose of this 9-item measure developed by McAuley and Mihalko (1998) was to assess participants' confidence in their abilities to engage in increasing intensities and durations of physical activity. A sample item is: "How confident are you that you can complete 10 minutes of physical activity at a light intensity three times next week?" Mean physical activity self-efficacy was computed separately for each of light, moderate and vigorous intensity physical activity. Cronbach's alpha measure of internal consistency for this scale has been found to be acceptable (α = .83; Foley et al., 2008; Nunnally, 1978).

Goal setting self-efficacy. The purpose of this 5-item measure developed by Rejeski et al. (2003) was to assess participants' confidence in their ability to set goals to be physically active. A sample item is: "How confident are you that you can set realistic goals for increasing and maintaining your physical activity in the next month?" Cronbach's alpha measure of internal validity for this scale has been found to be acceptable (α = .97; Nunnally, 1978; Rejeski et al., 2003).

Scheduling self-efficacy. The purpose of this 7-item measure developed by DuCharme and Brawley (1995) and modified by Woodgate, Brawley and Weston (2005) was to assess participants' confidence in their ability to organize and schedule physical activity over the next week. A sample item is: "The amount that I am confident that I could arrange my schedule to be physically active on my own is..." Cronbach's alpha measure of internal validity for this scale has been found to be acceptable (α = .87; Nunnally, 1978; Woodgate et al., 2005).

Barrier self-efficacy. This questionnaire was based on the barrier efficacy measure originally developed by Garcia and King (1991) and modified by Cramp and Brawley (2006). The purpose of this questionnaire was to assess participants' confidence in their ability to overcome seven barriers to engaging in physical activity. A sample item is: "How confident are you that you could engage in physical activity even if you have a lot of school work to do?" This measure was modified to include an additional item assessing participants' confidence in their ability to do physical activity even if they did not feel comfortable in their exercise clothing in front of other people. Cronbach's alpha measure of internal validity for this scale has been found to be acceptable (α = .82; Cramp & Brawley, 2006; Nunnally, 1978).

Outcome expectations. Participants' beliefs that engaging in regular physical activity would lead to specific valued outcomes was assessed using a 36-item outcome expectations questionnaire developed by Rodgers and Brawley (1991) and modified by Cramp and Brawley (2006). Outcomes were divided into three categories: social, physical and psychological. Measures were modified for youth from the measure developed by Cramp and Brawley, by removing concepts regarding childcare and making the items specific to youth (i.e., exercise with other similar adolescents, versus exercise with other similar new moms). Social outcomes included socializing with similar other adolescents, meeting new people, getting praise from family and friends for being active.

Physical outcomes included controlling weight, improving fitness and getting stronger. Finally, psychological outcomes included decreasing stress, feeling more energized and feeling accomplished.

Participants were asked to rate the likelihood and value of the outcome occurring as a result of participating in physical activity over the next four weeks. This scale was assessed on a 9-point Likert response scale, from 1 (*very unlikely or very low value*) to 9 (*very likely or very highly value*). Sample items include: "If I participated in physical activity over the next 4 weeks, the likelihood of it being fun is…" and " It is important to me that physical activity is fun".

In order to calculate outcome expectations, it was first determined whether the outcome was of value to the participant. Thus, any items that the participant did not indicate at least a value of 5 (*average value to me*) were replaced with the mean of the other "valued" items. If three or more items for a subscale were not given a value of at least 5, the values were not replaced and that participant was not included in the analyses for that subscale. Therefore, outcome expectations are a score of the mean of the valued items. Accordingly, this procedure was implemented 17 times in total. Higher values indicate higher outcome expectations. Cronbach's alpha measure of internal validity for these scales has been found to be acceptable ($\alpha > .88$; Cramp & Brawley, 2006; Nunnally, 1978).

Enjoyment. Participants' enjoyment of physical activity over the past week was assessed using the 18-item Physical Activity Enjoyment Scale (PACES; Kendzierski & DeCarlo, 1991). A sample item is: "Physical activity over the past week for me has been:" The participant responded on a 7-point Likert response scale, for example, from 1 (*I hate it*) to 7 (*I enjoy it*), or 1 (*I find it tiring*) to 7 (*I find it energizing*). Based on pilot testing, the following adaptations were made for youth: "I feel absorbed in it" changed to "I feel engaged in it"; "I feel gratifyed" changed to "I feel satisfied"; "I feel stimulated" changed to "I feel exhilarated". Exercise enjoyment was computed by determining the mean scale score. Higher values indicate greater exercise enjoyment. Motl (2001) reported that PACES had acceptable levels of internal consistency (α = .92; Nunnally, 1978).

Satisfaction. Participants' satisfaction was assessed using measures developed by Jeffery and colleagues (2006). There were three categories of satisfaction assessed in this study: satisfaction with progress (8-items), satisfaction with current state (5-items), and satisfaction with changes resulting from participating in the REACH program (11-items). Participants were asked to rate how satisfied they were with the outcome described and respond on a 9-point Likert response scale, from -4 (*very unsatisfied*) to 4 (*very satisfied*). Sample items from each category respectively included: "How satisfied are you with your total weight loss?"; "How satisfied are you currently with the ways clothes look and feel on your body?"; and "Based on the REACH program only, how satisfied are you with changes in your frustration about your weight?". Satisfaction was assessed by calculating participants' mean satisfaction for each subscale. Higher values indicate higher satisfaction. Cronbach's alpha measure of internal validity for this scale has been found to be acceptable (α > .76; Jeffery et al., 2006; Nunnally, 1978).

Internal Consistency of Psychosocial Measures

The internal consistency for each measure was examined using Cronbach's alpha at each time point. An acceptable level of internal consistency for each measure was based on Nunnally's (1978) guidelines of $\alpha > .70$. Single item alpha coefficients and predicted alpha coefficients for scale means if an item was deleted were used to determine whether an item should be removed from analyses. Any item that reduced the overall Cronbach's alpha coefficient to below .70 was removed. For the social outcome expectations subscale, internal consistency was poor at baseline, 6- and 13-weeks (Cronbach's α = .53, .58, .60 respectively; Nunnally, 1978). Inter-item correlation analysis revealed that items assessing "getting to be active outside my house", and "praise from friends and family for being physically active" were not strongly related to the other items, and suggested that removing these items would improve the internal consistency of the measure. Excluding these items provided acceptable reliability coefficients (Cronbach's α = .90, .92, .79 respectively; Nunnally, 1978). Results for social outcome expectations are reported with the exclusion of these two items.

In addition, at weeks 6 and 13, internal consistency was poor for current state satisfaction (Cronbach's α = .66, .68, respectively; Nunnally, 1978). Inter-item correlation analysis revealed that items assessing satisfaction with "current ability to complete household chores" and "current social life (doing things with your friends)" were not strongly related to the other items, and suggested that removing these items would improve the internal consistency of the measure. Excluding these items provided acceptable reliability coefficients (Cronbach's α =

.73, .81, .76, respectively; Nunnally, 1978). Results for current state satisfaction are reported with the exclusion of these two items. The Cronbach's alpha measures of internal consistency for all questionnaires at each respective time point can be found in Table 2.

Body Composition

Body fat, lean mass and fat free mass. Total body composition was measured by dual-energy x-ray absorptiometry (DXA; General Electric-Lunar iDXA, Ames Medical). DXA separates the body into fat mass, fat-free soft tissue and bone mineral content. Percent body fat is calculated for the whole body, and is separated into sections (i.e., head, right and left arm, trunk, android, gynoid, right and left leg). Fat free mass is made up of fat-free soft tissue and bone mineral content. For the purposes of this study, measures of body weight, total percent body fat, lean mass and fat free mass 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).

For the DXA assessment participants removed any metal items and were then asked to lie down on the DXA table. The assessor explained to the participant that they would lie on the table for about 10-12 minutes while the machine's arm would pass over them, and using a very low dose radiation (< 0.6 mR/hour, equivalent to a cross-country airplane flight) gather a detailed assessment of their body composition. As the effects of this low dose radiation on a developing fetus are unknown, all female participants were asked if there was any chance they could be pregnant before undergoing the scan.

Body mass index (BMI). BMI was calculated based on objective measurements of height and weight (Health-o-meter professional, Pelstar 500KL) using the equation BMI = weight (kg)/height $(m)^2$. Standardized BMI scores were computed and used in analyses. Participants were asked to take off their shoes and heavy clothing (e.g., winter jacket) and to stand on the scale facing away from the screen so that they could not see their weight. The assessor then recorded the participant's height and weight to the nearest 10^{th} of a centimeter or kilogram, respectively.

Physical Fitness Assessments

Aerobic fitness. Aerobic fitness was evaluated using a modified Balke incremental exercise protocol on a Woodway PPS treadmill as recommended for obese youth by Owens and Gutin (1999). Expired gases were analyzed using a metabolic cart (Cosmed Quark B^2 cardiopulmonary testing, Image Monitoring). Maximal oxygen consumption (VO_{2peak}) was defined as the highest 15-second average value attained for VO_2 (in ml/kg/min). At baseline, the participants were allocated two minutes to warm up and become comfortable on a treadmill by walking at 3.2 kilometers per hour (km/h) at a 0% incline. After this 2-minute warm-up, the speed increased to 4.8 km/h for another 2 minutes. For the remainder of the test, every 2 minutes the incline increased 2%, to a maximum of 20%, with the speed staying constant at 4.8 km/h. Participants were able to walk for the entire test at baseline.

At 13-weeks participants completed a modified version of the Balke as per recommendations for active obese youth (Skinner, 2005; Skinner et al., 1971).

For the first 2 minutes, the participants walked at a speed of 4.8 km/h and 0% incline. After 2 minutes, the incline increased to 6%, and the speed remained at 4.8 km/h. For the next 16 minutes, every 2 minutes the incline increased by 2%, to a maximum of 20%. After 18 minutes, the speed began to increase by 0.4 km/h every 2 minutes, with the incline remaining at 20%.

At baseline and 13-weeks the test was terminated when the participant indicated they were unable to continue the protocol, or when their vital signs warranted. VO_{2max} was attained when participants achieved the following criteria: 1) a heart rate equal to or greater than 85% of their heart rate max (220-age), 2) a respiratory exchange ratio of 0.95 or greater (Gutin et al., 2002; Gutin et al., 2005).

Strength. Isometric strength was assessed using a strain gauge manometer connected to the leg press and chest press HUR machines. Three maximum voluntary contractions (MVC) were performed of 3-5 second duration for the right leg and arm with a 1-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.

Exercise Intervention

During the 12-week intervention, all participants exercised at the EHPL and LBHH for 1 hour, 3 times per week for weeks 1 through 6; 1 hour, 2 times per week for weeks 7 through 9; and 1 hour 1 time per week for weeks 10 through 12. The exercise sessions were progressively less frequent to facilitate participants incorporating *independent* physical activity into their own daily schedule (i.e., outside of the supervised laboratory setting). After the last session of the intensive 12-weeks, participants were rewarded with an exercise session at the local community center activity room, in which they were able to play active video games and engage in group relay races.

Exercise conditions. Participants were randomized into either a moderate intensity or a vigorous intensity exercise condition. Both moderate and vigorous intensity exercise sessions included a warm-up, aerobic exercise, resistance training and cool down (see Table 3 for break down of time spent in group sessions, aerobic exercise and resistance training). Participants in the moderate intensity condition exercised at 40-55% of heart rate reserve (HRR) during aerobic training, and performed up to 3 sets of 15 repetitions during resistance training (Warburton, Nicol, & Bredin, 2006). In comparison, participants in the vigorous intensity condition exercised at 60-75% of HRR during aerobic training, and performed up to 3 sets of 10 repetitions during resistance training (Warburton et al., 2006). For the resistance training, both exercise conditions were taught and encouraged to continually adjust the weight so that the last three repetitions (i.e., repetitions 13-15 for the moderate condition and 8-10 for the vigorous condition) were very difficult. Therefore, the vigorous condition exercised with a higher amount of relative weight. To ensure all participants were improving their strength, the weights were increased uniformly every two weeks (i.e., by 1 kg for all exercises, except for the leg press which was increased by 2 kg). In addition, for the floor exercises, participants in the vigorous condition performed more challenging, but fewer repetitions of the exercises compared to the moderate condition (see Table 4 for list of exercises performed). Participants were given options to make the exercise harder when they felt it was too easy. The exercise leaders supervising the sessions ensured participants were pushing themselves to these criteria. During weeks 4 and 8, the exercise leaders reviewed each participant's strength progress over the past month. The exercise leader and the participant discussed performing all the exercises, and ensured the participants felt they were pushing themselves.

The aerobic and resistance training facilities were located adjacent to one another. The moderate and vigorous exercise conditions exercised at the same time such that while one group was engaging in resistance training, the other exercise condition was performing aerobic activity. Concealment of exercise condition allocation was ensured by never allowing the groups to see each other exercise, or the intensity at which participants in the other group were working.

The intervention was implemented in smaller waves of participants; Wave 1 had nine participants (4 moderate, 5 vigorous) and Wave 2 had 22 participants (11 moderate, 11 vigorous). Each exercise condition had the same two exercise leaders for the entire 12-week intervention, however some of the leaders changed between waves. All exercise leaders were trained graduate or senior undergraduate students at UWO. Exercise leaders tried to foster a team environment during all exercise sessions. For example, every session finished with the team (i.e., the group of individuals in each exercise condition in each wave) doing their team cheer, leaders commended improvements made during team exercises (i.e., everyone in the team being able to hold the "plank" core exercise longer every week), and team work completing the exercises was encouraged.

Table 3

Time spent in GMCB Sessions, Aerobic and Resistance Exercise

Day	Moderate Condition	Vigorous Condition
Monday	4:30-4:50 - GMCB	5:00-5:20 - GMCB
	4:50-5:10 - Aerobic exercise	5:20-5:40 - Aerobic exercise
	5:10-5:30 - Resistance training	5:40-6:00 - Resistance training
Wednesday	4:30-5:00 - Aerobic exercise	4:30-5:00 - Resistance training
	5:00-5:30 - Resistance training	4:30-5:00 - Aerobic exercise
Friday	4:30-5:00 - Aerobic exercise	4:30-5:00 - Resistance training
	5:00-5:30 - Resistance training	4:30-5:00 - Aerobic exercise

Note. For the first 6 weeks exercise sessions were on Mondays, Wednesdays and Fridays, for weeks 7-9 exercise sessions were on Mondays and Wednesdays and for weeks 10-12 exercise sessions were only on Mondays.

Aerobic exercise sessions. During the aerobic exercise sessions, participants exercised on treadmills, steppers, rowers and bikes. All participants wore heart rate monitors (Polar Electro Oy, Kempele, Finland) and were given instructions to keep their heart rate at a specific intensity based on their condition assignment (within a range of 10 beats per minute). After exercising for at least 10 minutes, participants were asked to report their rate of perceived exertion as a subjective measure of physical exertion (Robertson et al., 2005). Participants in the moderate intensity exercise condition were asked to exercise at an RPE of 4-6, and the vigorous intensity exercise condition at an RPE of 7-9 (Bar-Or & Rowland, 2004). Heart rate intensity zones were continuously adjusted to ensure the participants remained in the correct RPE range for their respective group assignment throughout the 12-week intervention. The heart rate data were downloaded and analyzed to serve three purposes: 1) As a manipulation check to ensure participants exercised at their prescribed intensity, 2) as motivation, and 3) to track progress. At the beginning of each session, participants were told their average heart rate from the previous session and how many minutes they were in their target zone. To enhance motivation in each session, if participants' average heart rate was in their prescribed target heart rate zone, they were rewarded by being granted permission to use their own personal music device (e.g., iPod, MP3 player) to exercise with during the next session.

Resistance training sessions. On days when the team started on resistance training (e.g., the moderate intensity group on Fridays; see Table 3), the warm-up included running the stairs in the building. Every week the warm-up was made progressively more difficult for each exercise condition. For example, in the first week the participants in the moderate condition completed the first two flights of stairs for warm-up, while participants in the vigorous condition completed three flights of stairs for warm-up. Every week thereafter, participants completed an additional set of the stairs until they were successfully running up all flights of stairs in the building (i.e., down four flights of stairs, across the main level, and up four flights of stairs in the other stairwell). When exercise sessions were cut back to twice per week, the groups alternated starting first in the resistance training on Wednesdays. On the days when participants began exercising in the aerobic room, they did not complete the stairs as participants were assumed to be "warmed-up" from their aerobic activity and ready to begin resistance exercises.

After the warm-up, every resistance training session began with the group completing the plank core exercise together (see Table 4 for progressions). Following this abdominal and back strengthening exercise, participants performed between 5-8 exercises on pneumatic resistance machines (HUR, Finland), and 3-6 free weight and body weight exercises (see Table 4 for a list of each exercise performed). The resistance training program ensured that all major muscle groups were trained, with a breakdown of seven lower body exercises, three core exercises, and six upper body exercises (see Table 4). Participants were asked to complete up to three sets (at their respective exercise condition intensity) of each of the resistance exercises during the supervised exercise session.

Table 4

Summary of Resistance Exercises

Resistance Exercise	Moderate	Vigorous
Plank	15 sec + 5 sec /week	30 sec + 5 sec /week
Leg press	3 x 15 reps	3 x 10 reps
Latissimus pull	3 x 15 reps	3 x 10 reps
Leg abduction and adduction	3 x 15 reps	3 x 10 reps
Leg curls and extensions	3 x 15 reps	3 x 10 reps
Tricep/bicep curls	3 x 15 reps	3 x 10 reps
Chest press	3 x 15 reps	3 x 10 reps
Lunges	3 x 7 per leg	3 x 7 per leg*
Partner Sit-ups	3 x 15 with 4 lb ball	3 x 10 8 lb ball
Partner Side twists	3 x 15 with 4 lb ball	3 x 10 8 lb ball
Push-ups	3 x 15 from knees	3 x 15 (push to toes)
Shoulder raises	3 x 15 reps	3 x 10 reps
Skipping	15 sec + 5 sec/week	30 sec + 5 sec/week

Note. Reps = repetition; * = leg on low bench, progress to holding hand weights.

Group-Mediated Cognitive-Behavioural (GMCB) Intervention

During the 12-week intervention, participants in each exercise condition engaged in identical weekly group behaviour change sessions. For each wave of participants, the group consisted of only individuals in the same exercise condition and will be referred to as the "team" from herein (i.e., all participants in the moderate condition were on the same team). The leader of the GMCB sessions for both exercise conditions was also the exercise leader for the vigorous intensity exercise group and had been trained to facilitate GMCB sessions by an expert in the field. These sessions were delivered in a group setting, were based on the GMCB intervention model (Brawley et al., 2000) and occupied the first 20 minutes of each Monday session. In total, there were 12 GMCB sessions summing a total of 240 minutes. The purpose of these sessions was to help participants develop the self-regulatory skills necessary to become and remain physically active after the intervention ended. Participants were taught how to self-monitor, set goals, plan regular physical activity and overcome barriers to physical activity. For example, participants monitored their daily physical activity behaviour and the team brainstormed solutions to overcome barriers to physical activity. Weekly session content is detailed below.

Week 1. One of the central tenants to GMCB interventions is that the learning of self-regulatory skills is facilitated through a cohesive group environment (Brawley et al., 2000). Thus, the primary aim of this group session was to begin to foster a cohesive group, which was facilitated through the group coming up with a team name and cheer. Once the group was set as a "team", the GMCB session leader explained how all the participants were selected for REACH because the researchers believed that the participants were very likely to succeed in becoming more physically active. Furthermore, the GMCB session leader discussed how the participants were even more likely to be successful in making and *maintaining* an active lifestyle because they were now part of a team.

Self-monitoring was the first self-regulatory skill introduced. Participants were given pedometers and physical activity logs, and all teams set the same team goal of everyone within the group monitoring their own physical activity over the next week. Participants were also asked to think about their main reason(s) for wanting to become more physically active.

Week 2. Participants discussed the physical activity each person completed over the past week and reflected on whether they thought they should engage in more or less physical activity the following week. Each individual set a personal goal to continue to monitor physical activity over the next week. The team set a team goal to increase the number of steps the team took collectively (based on their pedometers). Team goals were set by the team discussing the number of steps they could realistically collectively take over the next week. In order to help participants become aware of multiple benefits of becoming more active other than simply losing weight, the team then discussed each participant's reasons for wanting to change. Similarities between participants in the team were discussed, and the GMCB session leader summarized the main reasons the team wanted to become more active. In order to continue to foster group cohesion, the 'buddy system' was set-up. Each participant chose another participant in the team to pair up with and pairs were instructed to contact one another over the next week to discuss each other's physical activity over the past 7 days. The GMCB session leader encouraged the team to adopt the goal to engage in physical activity at least five times per week for at least 30 minutes. To accomplish this, in addition to attending the REACH exercise sessions three times per week, all participants were encouraged to engage in at least 30 minutes of moderate or vigorous physical activity on at least two days of the week on their own. Participants continued to monitor physical activity over the next week.

Based on social cognitive theory's (Bandura, 1986) principles of mastery and vicarious learning, one of the methods used to reinforce healthy *behaviour* changes the participants made during REACH was through the "REACH rewards" program. When participants were on time for REACH, exercised at the right heart rate intensity, completed their weekly GMCB homework assignment, or took extra initiative to make healthy behaviour changes (i.e., took the four flights of stairs up to the program instead of the elevator), they received a "ticket to success". These tickets to success were ballots on which they entered their name into a draw for an iPod shuffle. This system was introduced at the end of the second GMCB session. Tickets to success were given out in front of the team when participants showed the leader their completed homework, for engaging in their assigned exercise intensity, and for showing up on time for the session. Participants could attain up to five tickets to success per exercise and GMCB session.

Week 3. Partners started the discussion by introducing one another's "buddy", saying something unique about their buddy and what physical activity their buddy had done over the past week. Steps taken by the team were added up and the participants discussed why the team did or did not achieve the group goal for total number of steps taken. Based on this discussion, and this week's lesson on the FITT principle (Frequency, Intensity, Time and Type), each participant set an individual physical activity goal for the next week. The participants all contributed to setting a new team goal for physical activity over the next week pertaining to increasing the number of steps taken as a team. Participants continued to monitor physical activity over the next week and set out to achieve their physical activity goals.

Week 4. The team discussed the physical activity they engaged in over the past week. Subsequently, participants reflected on why they did or did not achieve their individual and team goals. These reflections segued into a discussion of barriers to physical activity. To further foster group cohesion, the team brainstormed solutions to overcome each others' barriers and discussed how they could use these solutions in their daily lives. Outcome expectations play an important role in making behavioural changes, as an individual is more likely to make the change if they perceive there to be benefits resulting from the change (Bandura, 1989). This notion provided the theoretical basis for participants composing mission statements. Participants were told important components that should be included in a healthy lifestyle mission statement (i.e., what behaviour you want to change, why you want to change it, and what benefits you will get from maintaining the healthy behaviour) and were given an example. For homework, all participants were asked to make their own personal mission statement, to continue to monitor physical activity over the next week, and to achieve their physical activity goals.

Week 5. The team discussed how they effectively overcame barriers to physical activity over the past week. Any additional barriers and solutions were discussed. Willing participants shared their mission statements with the team. The team discussed how their mission statement could motivate them to maintain an active lifestyle. Next, the idea of 'rewards' was introduced and the team discussed how they could use different rewards to motivate themselves to exercise. Participants discussed material rewards (i.e., clothes), enjoyable activities (i.e., watching favorite television show) and intrinsic rewards gained from engaging in physical activity (i.e., feeling better about self, feeling more energized). Participants then discussed active and sedentary activities in their day and set a goal to make at least one sedentary activity more active over the next week. Participants continued to monitor their physical activity over the next week.

Week 6. Participants engaged in a review of the past five sessions by playing an interactive quiz game led by the GMCB session leader. Each participant competed against the other participants. The winner received 10 tickets to success, while second and third place received 5 and 2 tickets to success, respectively. Questions included "How would you overcome the barrier of not having enough time to be physically active?" and "How many days of the week should you engage in physical activity?" Participants had to run on the spot and when they knew the answer they could sit down and the first person to sit was asked to answer the question. This game took approximately 15 minutes and was a fun and engaging way for participants to review the material they had learned over the past 5 weeks. The final activity in this session was based on Bandura's (1982) notion that self-efficacy plays an essential role in making and maintaining healthy lifestyle choices. Given that the most potent source of self-efficacy are mastery experiences, it was important to ensure participants were aware of the behaviour change(s) they had successfully made during REACH. Thus, participants were asked to think of and write down a health behaviour change they were proud of accomplishing since joining REACH. Utilizing the concept of social learning (Bandura, 1986), sharing these reflections with the team was encouraged and turned into team discussion whenever possible. Participants continued to monitor their physical activity over the next week.

Week 7. This week was the start of the weaning process wherein participants were asked to come only twice per week to exercise. This session began with participants being asked to stand up if they had engaged in at least 30 minutes of moderate or vigorous physical activity on at least three days of the past week. Participants were asked to remain standing if they had engaged in at least 30 minutes of moderate or vigorous physical activity on at least four days of the past week, and again remain standing if they completed five days of 30 minutes of moderate or vigorous physical activity. The purpose of this exercise was to first, commend those who did achieve their individual and team goals, and second, to motivate those who did not achieve the goal - and had to sit down while their teammates stood - to achieve the goal for the next week. The team discussed what enabled participants to achieve the team physical activity goal. This discussion led to helping the participants learn to schedule daily physical activity (i.e., taking account for school, homework, work and other obligations). Participants were asked to plan out at least five 30-minute moderate or vigorous intensity physical activity sessions over the next week and were given “reward” stickers to place on the days that they achieved their goal. All participants set individual goals and the team set a new team physical activity goal.

Week 8. Similar to Week 7, this session began with participants being asked to stand (and remain standing) if they engaged in three, four or five minimum 30-minute moderate or vigorous intensity physical activity sessions over the past week. The team briefly discussed factors that enabled them to achieve their goals, and what they could do to help them achieve their goals this week. Another strategy to help participants engage in independent physical activity was to have the team help each other develop a physical activity plan that each participant could engage in at home. Similar to the past week, participants were asked to plan out at least five minimum 30-minute moderate or vigorous intensity physical activity sessions (ideally involving their new independent physical activity plan) over the next week and were given reward stickers to place on the days that they achieved their goal. Participants set a new independent and team physical activity goal for the following week. Participants were also asked to reflect and write down something they were proud of themselves for achieving over the past week.

Week 9. By this time, most participants had weeks when they had not achieved their physical activity goals. Failing to attain physical activity goals led to a group discussion about lapses and how to overcome them. Participants discussed and developed a plan about how they would overcome a lapse if they had a period of time in the future when they were not active. Building on outcome expectations, the team brainstormed all the "good" and "bad" ways that physical activity made them feel. Participants generally discussed that while sometimes physical activity made them feel sore or tired, the participants usually felt much better overall and were happier when they engaged in regular physical activity. For homework that week, participants were encouraged to continue to achieve their physical activity goals and to become more aware of how they felt before, during and after engaging in physical activity.

Week 10. This week participants were further weaned from supervised exercise and began to come only once per week to exercise. This session began similar to previous ones, as participants were asked to stand (and remain standing) if they engaged in three, four or five minimum 30-minute moderate or vigorous intensity physical activity sessions over the past week. Again, any issues participants had with achieving regular physical activity were discussed, and successes were celebrated. This session revolved around discussing specific cognitive strategies the participants could use to motivate themselves to do physical activity. For example, the participants discussed "cues to action" that would help them remember to be physically active. These cues included leaving reminder notes for themselves to exercise, putting gym shoes in their backpack, or using a sunny day to motivate them to exercise outside. The GMCB session leader also introduced the concepts of "thought stopping" and "positive self-talk". For example, participants were asked to list negative thoughts that went through their heads that affected their physical activity or healthy lifestyle choices (i.e., "I am so tired, I don't want to do any activity"). The GMCB session leader explained that when these negative thoughts went through their head in the future, the participants should try to first recognize the negative thought. Second, the participants should try to replace or reframe the thought so that it became more positive. From the aforementioned example, if the participant felt very tired and did not want to do physical activity, they could reframe this thought by thinking "I am sure tired now, however I know that after I go for my 30 minute walk-run, I will feel energized!" The participants were asked to keep track of when and how they used these strategies cognitive-behavioural over the next week.

Week 11. Participants discussed how they had used cues to action, thought stopping and positive self-talk over the past week. Due to the success of the Week 6 session in reviewing the concepts learned through the interactive game, the sessions for weeks 11 and 12 were run the same way. The questions this week focused on having participants come up with examples of how they currently used the skills they learned over the first 6 weeks in their weekly physical activity routines. For example, questions included "How do you make sure you do not forget to exercise" and "What is your physical activity goal and how are you achieving it?" In addition to engaging in four independent exercise sessions this week, participants were asked to write down any questions regarding the skills they had learned and bring them for the final session the following week.

Week 12. This session began similar to others, as participants were asked to stand (and remain standing) if they engaged in three, four or five minimum 30-minute moderate or vigorous intensity physical activity sessions over the past week. Again, any issues participants had with achieving regular physical activity were discussed, and successes were celebrated. Participants discussed how it feels to be an active person and part of an active team. In addition, participants discussed why they wanted to remain an active, healthy person and how each individual was planning on doing so. The interactive quiz this week focused on having participants come up with examples of how they currently used the skills they learned over weeks 7-11 in their weekly physical activity routines. For example, questions included "How do you stop and refocus negative thoughts?" and "What exercises do you regularly do at home?" Participants were then given the opportunity to ask any last questions they had. The GMCB session leader commended participants on their progress over the past 12 weeks and encouraged them to continue on with their healthy, active lifestyles. As a reward, later that week the participants went to a local YMCA and were given free use of active video games (e.g., Nintendo Wii, Dance Dance Revolution) and engaged in relay races in the gym, followed by a draw for the iPod.

Statistical Analyses

Physical activity (weekly energy expenditure, frequency, duration and volume), psychosocial variables (self-efficacy, outcome expectations, satisfaction, enjoyment, group cohesion and leader collaboration), body composition (percent body fat, lean mass, fat free mass and BMI) and fitness (aerobic and strength) outcomes were analyzed for time and group effects using repeated measures multivariate analysis of variance (MANOVA) and repeated measures analysis of variance (ANOVA). Regression analyses were used to examine self-efficacy, outcome expectations, enjoyment and satisfaction as predictors of physical activity at 13-weeks and 6-months. In addition, enjoyment and satisfaction were tested as potential mediators in the relationship between exercise condition and physical activity adherence using methods outlined by Baron and Kenny (1986). Significance levels for all statistical tests were set at $p < .05$ (Tabachnick & Fidell, 1996). Effect sizes (η^2) of 0.01, 0.06 and 0.14 were considered small, medium and large respectively (Cohen, 1988).

Results

Treatment of Data

Missing data. Missing data were replaced with the mean item score from participants of the same gender and exercise condition when 5% or less of the data were missing (Tabachnick & Fidell, 1996). This occurred 38 times in total for the psychosocial outcomes; all values were available for aerobic fitness, strength and body composition. If a participant failed to complete an entire measure, no values were entered and the participant was excluded from any analyses that included the missing measure, as this was deemed to be the most conservative method (Tabachnick & Fidell, 1996). Accordingly, 12 participants had incomplete data (1 participant missing all 6-week data; 7 participants excluded from social outcome expectations because of low value [< 5]; 1 participant missing 13-week enjoyment, group cohesion, planning and barrier self-efficacy; 1 participant missing 13-week group cohesion; 1 participant missing 2-week goal setting self-efficacy; and 1 participant missing 13-week 7-day PAR data).

Outliers. Values with a z-score above or below 3.29 respectively indicated an outlier (Tabachnick & Fidell, 1996). Using this method one outlier was found for each of the following variables: 13-week exercise self-efficacy, 6-week current state satisfaction, baseline weekly energy expenditure, baseline duration of physical activity per day and baseline chest strength. The imputation of one unit above or below the next highest or lowest value was implemented to treat all outliers (Tabachnick & Fidell, 1996).

Testing assumptions of statistical procedures. Histograms and tests of kurtosis and skewness were used to examine if the data were normally distributed. Weekly energy expenditure and volume of physical activity were positively skewed at baseline, however because of the nature of the participants (i.e., primarily sedentary obese adolescents), this distribution was thought to accurately represent baseline data, and thus energy expenditure and volume of physical activity were not normalized. All other variables were normally distributed.

Data were explored for violations of the statistical assumptions of the models employed: (a) repeated measures multivariate analysis of variance (MANOVA); including homogeneity of variance-covariance matrices, sphericity, linearity, multicollinearity, interval data and independent measures (Field, 2005), and (b) regression; including non-zero variance, multicollinearity, predictors uncorrelated with external variables, and homoscedasticity (Field, 2005). Violations of assumptions will be detailed below.

Statistical tests using the repeated measures MANOVA revealed the following violations to the assumptions of the model. Upon examination of the differences between study compliers versus dropouts, the assumption of homogeneity of variance was not met for 2 variables: volume of physical activity per week, and satisfaction with outcomes. However, examination of the variance-covariance matrices indicated that study compliers, of which there was a greater proportion within the sample, displayed greater variances when compared to dropouts. This finding indicates that the alpha level is conservative and the *F*-

statistic should be considered robust to this violation (Field, 2005; Tabachnick & Fidell, 1996). The assumption of sphericity was violated in both of the repeated measures ANOVAs examining physical outcome expectations and current state satisfaction. Consequently, the Greenhouse-Geisser correction was employed to determine significance of the *F*-statistic for these variables (Tabachnick & Fidell, 1996).

In the regression analyses, the assumption of multicollinearity was violated when examining 6-week self-efficacy as a predictor of 13-week physical activity, as goal-setting and planning self-efficacy were highly correlated ($r > .90$, $p < .001$). The violation of multicollinearity increases the chances of a type two error, and thus the prediction of the outcome (i.e., volume of physical activity) might not meet statistical significance due to larger standard errors of the beta coefficients (Tabachnick & Fidell, 1996). Finally, three social cognitive predictors were correlated with external variables, violating this assumption of the regression model. Specifically, 6-week assessments of the social cognitive variables of enjoyment and physical outcome expectations were significantly correlated with all three subscales of satisfaction (rs > .86, $p < .001$). Furthermore, 13-week assessment of planning self-efficacy was significantly correlated with enjoyment ($r = .89$, $p < .001$). Caution should be used in interpreting significant models including these variables due to the correlations with external variables.

Flow of Participants

The flow of participants through the study is presented in Figure 1.

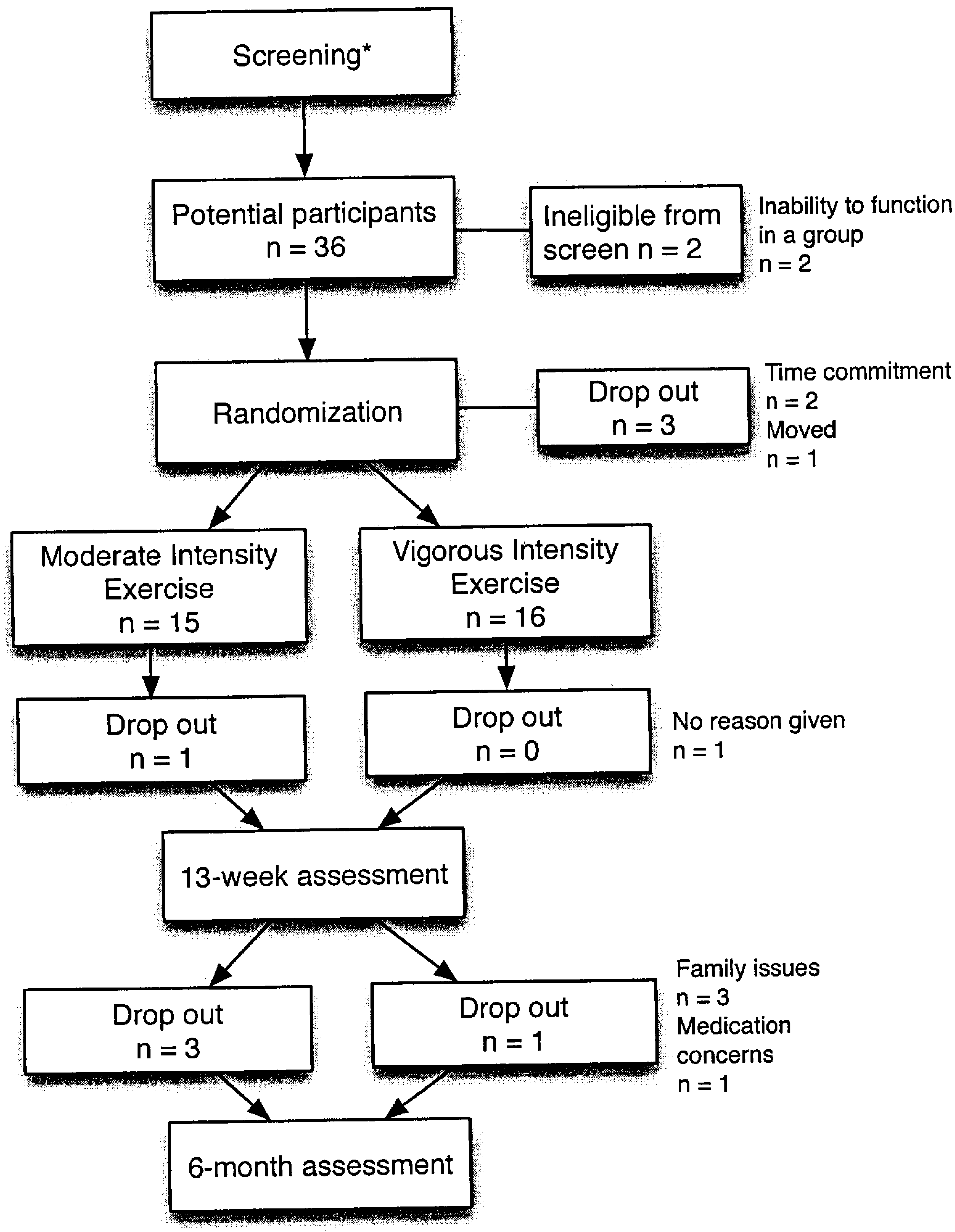

Figure 1. Participant flow through the REACH 12-week exercise and GMCB program.

*Note. Recruitment and initial screening were conducted by a social worker at the hospital. Data regarding interested participants and screening were unavailable for waves 1 and 2 specifically.

Attendance and Study Compliance

To ascertain whether attendance to the exercise sessions differed between exercise conditions, an independent *t*-test was conducted. There was no significant difference in attendance to the exercise sessions between the moderate exercise condition (*M* = 84.6%, *SD* = 13.0) and the vigorous exercise condition (*M* = 85.7%, *SD* = 12.2), $t(28) = -0.24$, $p = .81$. Participants were considered to have dropped out if they told the researchers they no longer wanted to be in the study, or if they did not attend the exercise sessions for 4 consecutive weeks. A Mann-Whitney *U* test was conducted to evaluate if there were differences in dropout rates between exercise conditions. Results indicated there were no significant differences in number of dropouts between exercise conditions, $z = -1.52$, $p = .13$. Participants were equally likely to drop out of the moderate and vigorous exercise conditions.

Two separate multivariate analysis of variances (MANOVA) were run to examine if there were physical or psychological baseline differences between study compliers and dropouts. The first MANOVA indicated there were no significant differences between study compliers and dropouts for age, percent body fat, lean mass, fat free mass, BMI, aerobic fitness, weekly energy expenditure, or strength, $F(9,20) = 1.47$, $p = .23$, $\eta^2 = .40$. However, significant differences in social cognitions emerged between study compliers and dropouts, $F(13, 12) = 3.76$, $p < .05$, $\eta^2 = .80$. Follow-up univariate analyses indicated there were significant baseline differences between study compliers and dropouts for self-efficacy for light, $F(1, 24) = 6.02$, $p < .05$, $\eta^2 = .20$, and moderate intensity physical activity, $F(1, 24) = 6.83$, $p < .05$, $\eta^2 = .22$. Specifically, self-efficacy for light and moderate physical activity was higher in study compliers ($M_{light} = 89.68$, $SD = 10.12$; $M_{moderate} = 81.90$, $SD = 15.90$) as compared to dropouts ($M_{light} = 76.00$, $SD = 15.53$; $M_{moderate} = 62.00$, $SD = 11.93$). Tables 5 and 6 display the means and standard deviations for the baseline physical and psychological variables for study compliers and dropouts.

Table 5

Physical Activity and Physical Outcome Variables at Baseline for Study Compliers Versus Dropouts

	Study Compliers (n = 26)		Dropouts (n = 5)	
Variable	*M*	*SD*	*M*	*SD*
Age	14.44	1.70	14.27	1.51
% Body fat	44.73	4.90	44.40	3.63
Lean mass (kg)	50.68	10.18	41.98	5.12
Fat free mass (kg)	52.73	10.14	44.23	5.57
BMI (kg/m^2)	33.85	5.01	30.02	0.58
VO_2 Max (ml/kg/min)	30.49	6.13	30.94	4.58
Energy expenditure (kkcal/kg/week)	237.62	23.94	248.00	31.69
Strength – chest (N/m)	107.12	31.04	97.00	22.62
Strength – leg (N/m)	120.76	51.51	176.60	34.02

Table 6

Psychosocial Variables at Baseline for Study Compliers and Dropouts

	Study Compliers (*n* = 26)		Dropouts (*n* = 5)	
Variable	*M*	*SD*	*M*	*SD*
SE - goals	71.52	15.04	70.40	16.02
SE - planning	76.87	16.77	66.00	16.55
SE - PA				
Light	89.68*	10.12	76.00*	15.53
Moderate	81.90*	15.90	62.00*	11.93
Vigorous	66.83	24.14	47.33	18.77
SE - barrier	67.21	16.07	63.86	8.94
Social OE	7.26	1.59	6.00	1.84
Physical OE	8.01	0.94	7.16	1.13
Psychological OE	7.66	1.28	8.00	1.06
S - outcomes	1.27	1.52	1.32	0.44
S - current	1.21	1.87	0.53	1.63
S - REACH	2.32	1.47	2.33	1.57
Enjoyment	4.93	1.12	5.02	0.87

Note. SE = Self-efficacy; PA = Physical activity; OE = Outcome expectations; S = Satisfaction. Self-efficacy was measured on a 0 (*Absolutely not confident*) to 100 percent (*Absolutely confident*) scale. Outcome expectations were measured on a 1 (*very unlikely*) to 9 (*very likely*) scale. Satisfaction was measured on a -4 (*very unsatisfied*) to 4 (*very satisfied*) scale. Enjoyment was measured on a 1 (*I hate it*) to 7 (*I enjoy it*) scale. * = significant difference between groups, $p < .05$.

Group Equivalency at Baseline

To assess whether there were differences between exercise conditions at baseline for age and gender, *t*-test and Mann-Whitney *U* analyses were conducted, respectively. There were no significant differences between the exercise conditions at baseline for age, $t(29) = -1.30$, $p = .20$; or gender $z = -0.14$, $p = .89$. In order to examine if there were physical (percent body fat, muscle mass, fat free mass, BMI, aerobic fitness [VO_2 max], strength, weekly energy expenditure, frequency of physical activity bouts, duration of physical activity bouts, volume of physical activity bouts) or psychosocial (cohesion, collaboration, self-efficacy, outcome expectations, satisfaction, enjoyment) differences between exercise conditions, two separate MANOVAs were run. The overall omnibus *F*s indicated there were no significant differences between exercise conditions for the physical variables, $F(11, 18) = 0.26$, $p = .99$, $\eta^2 = .20$, or the psychosocial variables, $F(16, 9) = 1.17$, $p = .42$, $\eta^2 = .14$. The demographic characteristics, physical, and psychosocial outcome variables at baseline for each treatment condition are presented in Tables 7, 8, and 9, respectively.

Table 7

Demographic Characteristics at Baseline

Variable	Moderate Intensity Exercise Condition (*n* = 15)		Vigorous Intensity Exercise Condition (*n* = 16)	
	M	*SD*	*M*	*SD*
Age (years)	13.93	1.76	14.70	1.57
Gender				
Female	9		10	
Male	6		6	

Table 8

Physical Outcome Variables and Physical Activity at Baseline

Variable	Moderate Intensity Exercise Condition (n = 15)		Vigorous Intensity Exercise Condition (n = 16)	
	M	*SD*	*M*	*SD*
% Body fat	44.31	3.60	45.22	5.49
Lean mass (kg)	48.77	10.82	49.79	9.38
Fat free mass (kg)	42.52	4.50	43.88	5.13
BMI (kg/m^2)	32.88	5.06	33.50	4.61
VO_2 Max (ml/kg/min)	28.54	3.72	29.12	4.64
Strength – chest (N/m)	108.57	32.78	104.25	27.35
Strength – leg (N/m)	127.79	53.69	130.88	52.68
EE (kkcal/kg/week)	239.44	26.09	238.90	24.12
Frequency of PA (days/week)	3.53	2.17	3.50	2.37
Duration of PA (minutes/day)	66.60	47.08	62.59	52.11
Volume of PA (minutes/week)	243.63	174.70	280.57	285.81

Note. PA = Physical activity; EE = energy expenditure.

Table 9

Psychosocial Outcome Variables at Baseline

	Moderate Intensity Exercise Condition ($n = 15$)		Vigorous Intensity Exercise Condition ($n = 16$)	
Variable	*M*	*SD*	*M*	*SD*
SE - goals	64.53	17.33	73.88	13.01
SE - planning	70.86	16.70	73.75	18.94
SE - PA				
Light	82.89	15.42	85.83	12.32
Moderate	73.33	23.33	76.67	16.60
Vigorous	60.89	26.16	55.63	26.30
SE - barrier	60.14	19.28	67.63	15.85
Social OE	7.21	1.83	6.86	1.59
Physical OE	7.73	1.07	7.77	1.01
Psychological OE	7.31	1.60	7.26	1.68
S - outcomes	1.22	1.47	1.30	1.42
S - current	1.16	1.92	1.23	1.66
S - REACH	2.06	1.71	2.46	1.19
Enjoyment	4.71	1.05	4.93	1.16

Note. SE = Self-efficacy; PA = Physical activity; OE = Outcome expectations; S = Satisfaction. Self-efficacy was measured on a 0 (*Absolutely not confident*) to 100 percent (*Absolutely confident*) scale. Outcome expectations were measured on a 1 (*very unlikely*) to 9 (*very likely*) scale. Satisfaction was measured on a -4 (*very unsatisfied*) to 4 (*very satisfied*) scale. Enjoyment was measured on a 1 (*I hate it*) to 7 (*I enjoy it*) scale.

Manipulation Checks

Difference in aerobic intensity between exercise conditions.

Participants in the moderate condition were instructed to exercise at 40-55% heart rate reserve (HRR), while those in the vigorous condition were to exercise at 60-75% HRR. To ascertain whether participants in the moderate and vigorous conditions complied with these different exercise intensities, a 2 (Exercise Condition: moderate vs. vigorous) x 21 (Time: exercise sessions performed) repeated measures ANOVA was conducted. The main effect for time was not significant, $F(20, 1) = 8.81$, $p = .26$, $\eta^2 = .99$. The ANOVA revealed a significant main effect for exercise condition, $F(1, 20) = 65.48$, $p < 0.001$, $\eta^2 = .77$. The Time x Exercise Condition interaction was not significant, $F(20, 1) = 1.95$, $p = .52$, $\eta^2 = .98$. Comparison of the percent HRR means for each REACH exercise session for both conditions indicated that participants in the moderate condition exercised at significantly lower percentage HRR (M = 42% HRR, SD = .07) as compared to those in the vigorous condition (M = 63% HRR, SD = .05). Mean percent HRR for both conditions per exercise session are displayed in Figure 2.

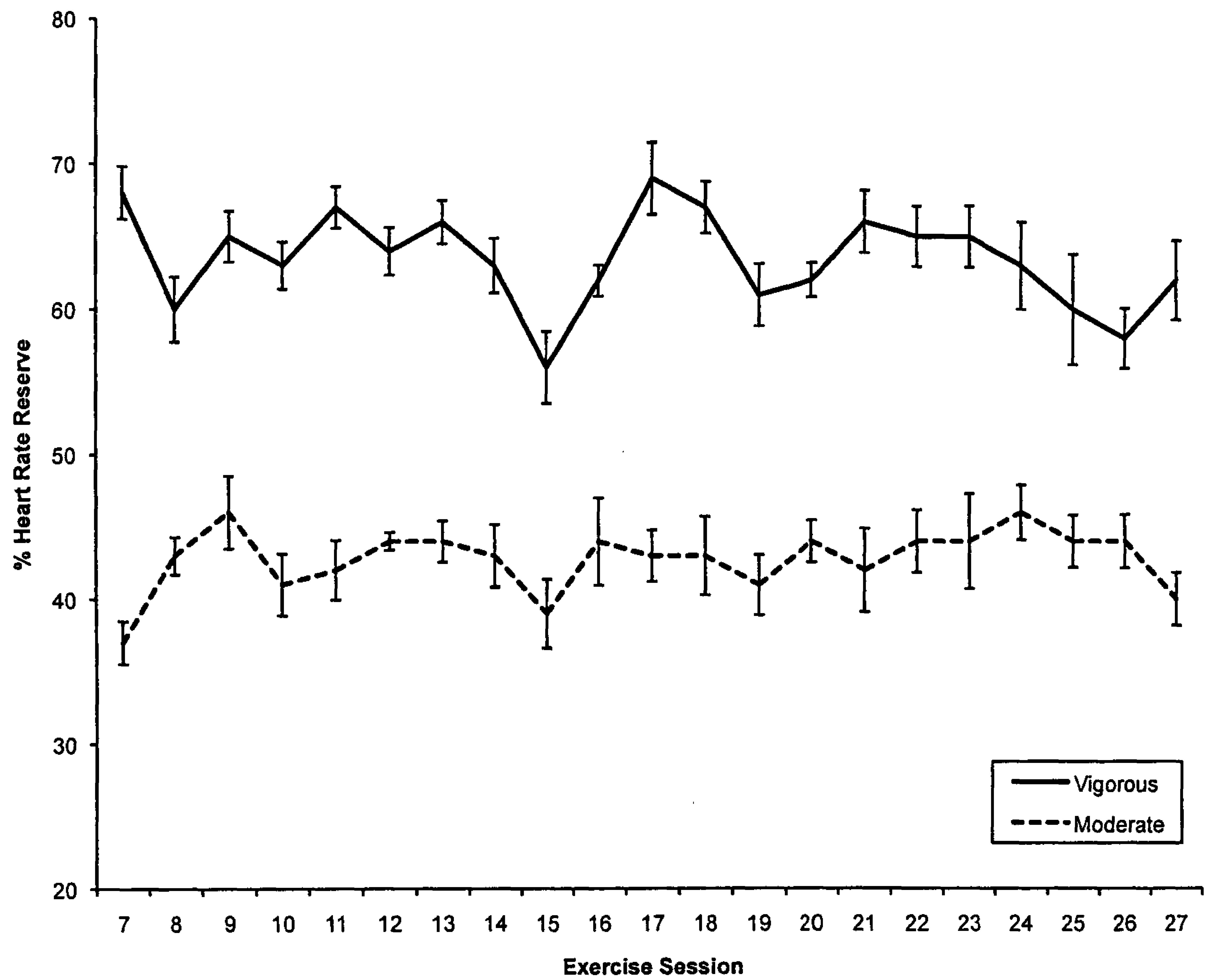

Figure 2. Mean daily percent of heart rate reserve for both exercise conditions during structured laboratory exercise sessions. Error bars represent standard error.

Difference in rate of perceived exertion between exercise conditions. Given that participants in the vigorous condition were asked to exercise at a higher HRR, it was thought that participants in the vigorous condition would report higher subjective perceived exertion as compared to the moderate condition. To examine if participants in the two exercise conditions perceived they were exercising at significantly different intensities, a 2 (Exercise Condition: moderate vs. vigorous) x 23 (Time: exercise sessions performed) repeated measures ANOVA was conducted. The ANOVA indicated a significant main effect for time, $F(22, 1) = 2.51$, $p < 0.001$, $\eta^2 = .11$, and a significant main effect for exercise condition, $F(1, 20) = 176.64$, $p < 0.001$, $\eta^2 = .15$. On average, participants in the moderate condition perceived they were exerting themselves significantly less ($M = 4.95$, $SD = 0.42$) than those in the vigorous condition ($M = 7.82$, $SD = 0.57$). The Time x Exercise Condition interaction was also significant, $F(1, 21) = 1.81$, $p < 0.05$, $\eta^2 = .08$, indicating that over time, participants in the vigorous condition perceived they were working at increasingly harder exercise intensities as compared to participants in the moderate condition. Mean RPE for both conditions per exercise session are displayed in Figure 3.

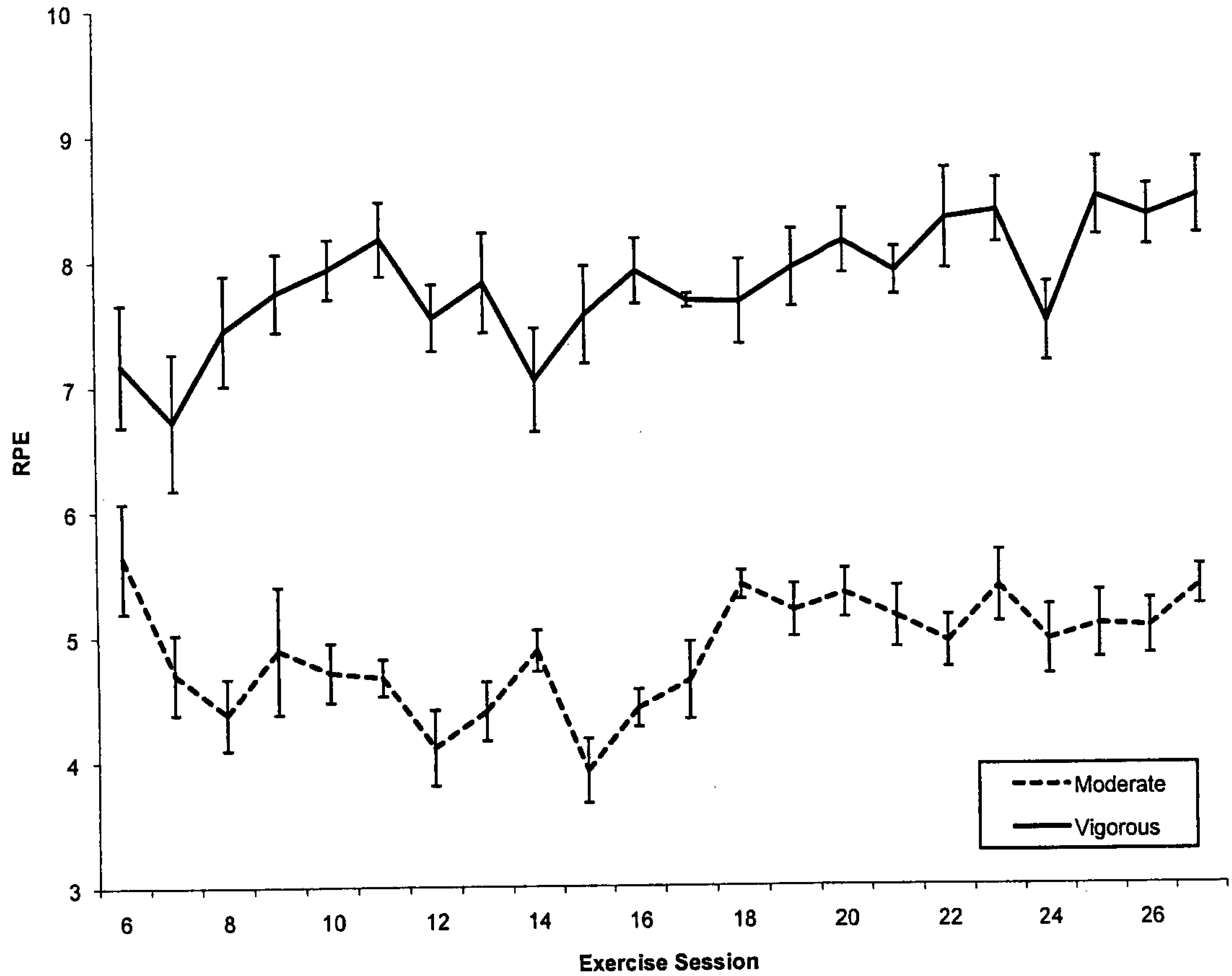

Figure 3. Mean daily rate of perceived exertion per aerobic exercise session for both exercise conditions. Error bars represent standard error.

Group cohesion and collaboration in both exercise conditions. GMCB interventions assume that self-regulatory skills will be learned through a strong cohesive group and collaborative relationship(s) with the leader(s). To assess whether cohesiveness and collaboration with the GMCB session leader and the exercise leaders increased equally in both exercise conditions, a 2 (Exercise Condition: moderate vs. vigorous) x 2 (Time: 2- and 13-week) repeated measures MANOVA was conducted on cohesion and both types of collaborations. The overall omnibus *F* indicated there was a significant main effect for time, $F(3, 24) = 6.07$, $p < .01$, $\eta^2 = .43$. Specifically, regardless of exercise condition, by week 13, there were significant increases in group cohesion, $F(1,26) = 4.61$, $p < .05$, $\eta^2 = .15$, and GMCB session leader collaboration, $F(1,26) = 15.17$, $p < .001$, $\eta^2 = .37$. While the main effect for time for exercise leader collaboration did not reach standard levels of significance, $F(1,26) = 3.37$, $p = .08$, $\eta^2 = .12$, comparison of estimated marginal means indicated exercise leader collaboration increased between week 2 ($M_{moderatecondition} = 4.32$, $SE = 0.11$; $M_{vigorouscondition} = 4.30$, $SE = 0.14$) and week 13 ($M_{moderatecondition} = 4.46$, $SE = 0.13$; $M_{vigorouscondition} = 4.51$, $SE = 0.12$) for both conditions. There were no significant main effects for exercise condition or Time x Exercise Condition interactions for group cohesion, GMCB leader collaboration or exercise leader collaboration, *p*s > .23. As anticipated, after the final GMCB session (13-week assessment), means for cohesion and both types of collaboration were greater than 4.30, indicating that participants "agreed" or "strongly agreed", on average, that they were part of a cohesive group and had developed collaborative relationships with the GMCB session and exercise leaders. Figures 4, 5 and 6 display the 2- and 13-week means for both conditions for group cohesion, group leader collaboration and exercise leader collaboration, respectively.

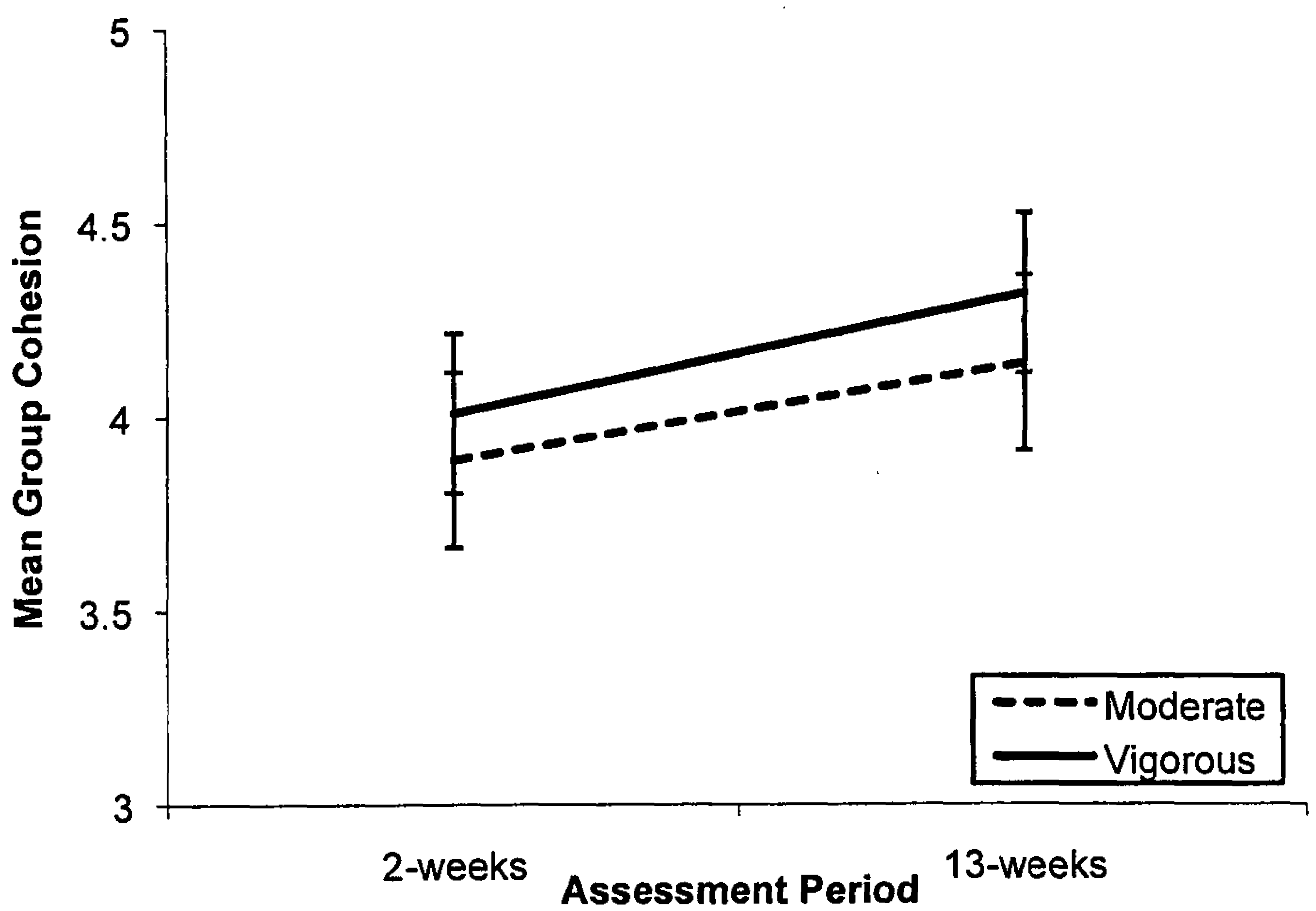

Figure 4. Mean group cohesion at 2- and 13-weeks for both conditions. Error bars represent standard error.

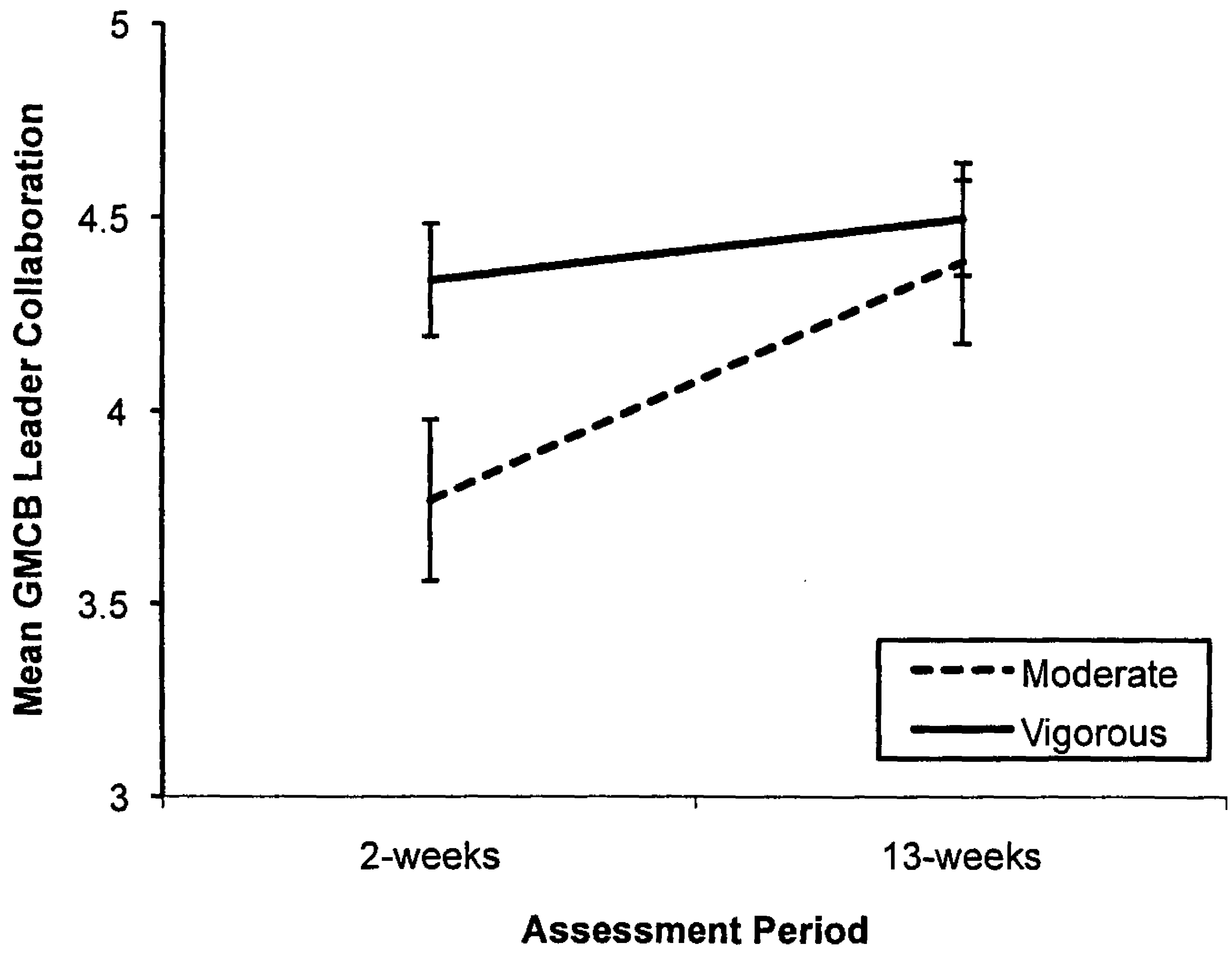

Figure 5. Mean GMCB leader collaboration at 2- and 13-weeks for both conditions. Error bars represent standard error.

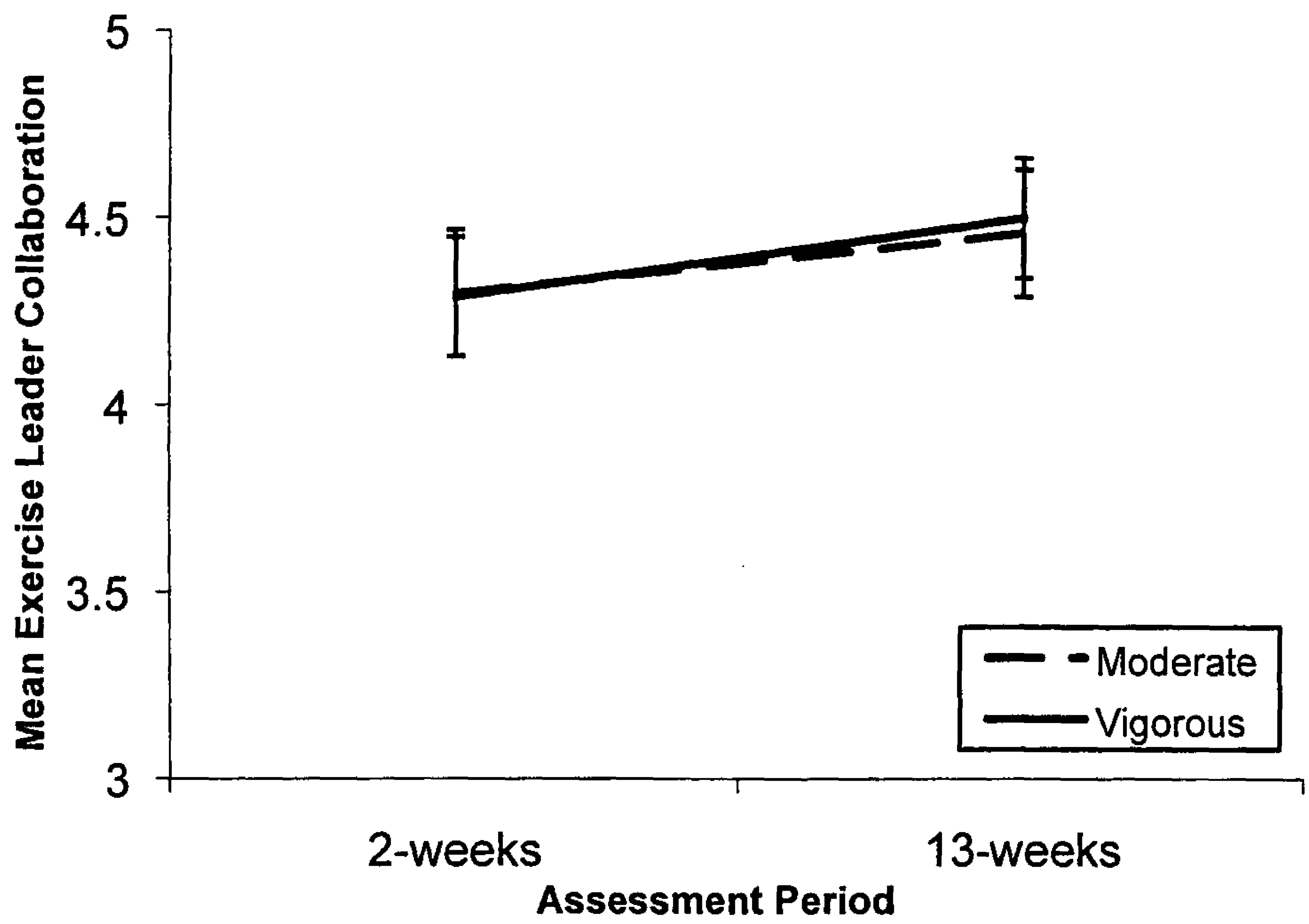

Figure 6. Mean exercise leader collaboration at 2- and 13-weeks for both conditions. Error bars represent standard error.

Main Outcome

Group differences in physical activity. It was hypothesized that compared to participants in the moderate condition, weekly energy expenditure, frequency, duration and volume of physical activity at both the 13-week and 6-month assessments would be greater in the vigorous condition. In order to test this hypothesis, a 2 (Exercise Condition: moderate vs. vigorous) x 3 (Time: baseline, 13-week and 6-month) repeated measures MANOVA was run on all physical activity variables examined within the 7-day physical activity recall (PAR) measure. An overall main effect for time was found for the physical activity variables, $F(8, 16) = 2.56$, $p < .05$, $\eta^2 = .56$. Follow-up univariate ANOVAs indicated that regardless of exercise condition, over time there were significant increases in weekly energy expenditure, $F(2, 46) = 4.64$, $p < .05$, $\eta^2 = .17$, frequency of physical activity per week, $F(2, 46) = 10.25$, $p < .001$, $\eta^2 = .31$, and volume of physical activity per week, $F(2, 46) = 3.80$, $p < .05$, $\eta^2 = .14$. There was no main effect for time for duration of physical activity bouts, $F(2, 46) = 0.50$, $p = .58$, $\eta^2 = .02$. Paired *t*-tests indicated that regardless of exercise condition, there were significant differences in weekly energy expenditure, frequency and volume of physical activity between baseline and 13-weeks, $p < .001$; and between baseline and 6-months for frequency and volume of physical activity, $p < .05$. Contrary to hypothesis one, there was no main effect for exercise condition, $F(4, 20) = 0.13$, $p = .97$, $\eta^2 = .03$, or Time x Exercise Condition interaction, $F(8, 16) = 0.91$, $p = .53$, $\eta^2 = .31$. Figures 7, 8, 9 and 10 display these findings.

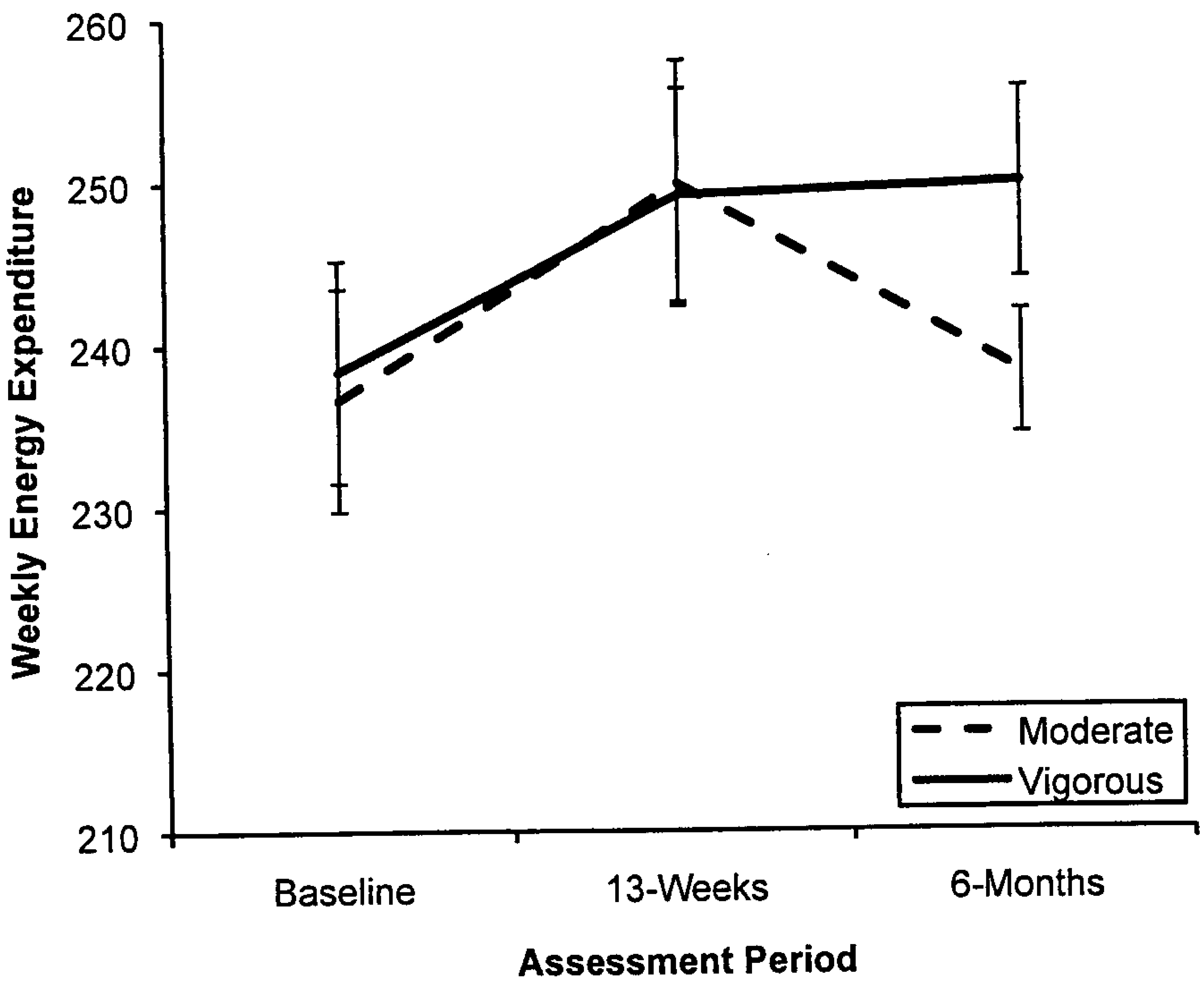

Figure 7. Mean weekly energy expenditure in kcal/kg/week at baseline, 13-weeks and 6-months. Error bars represent standard error.

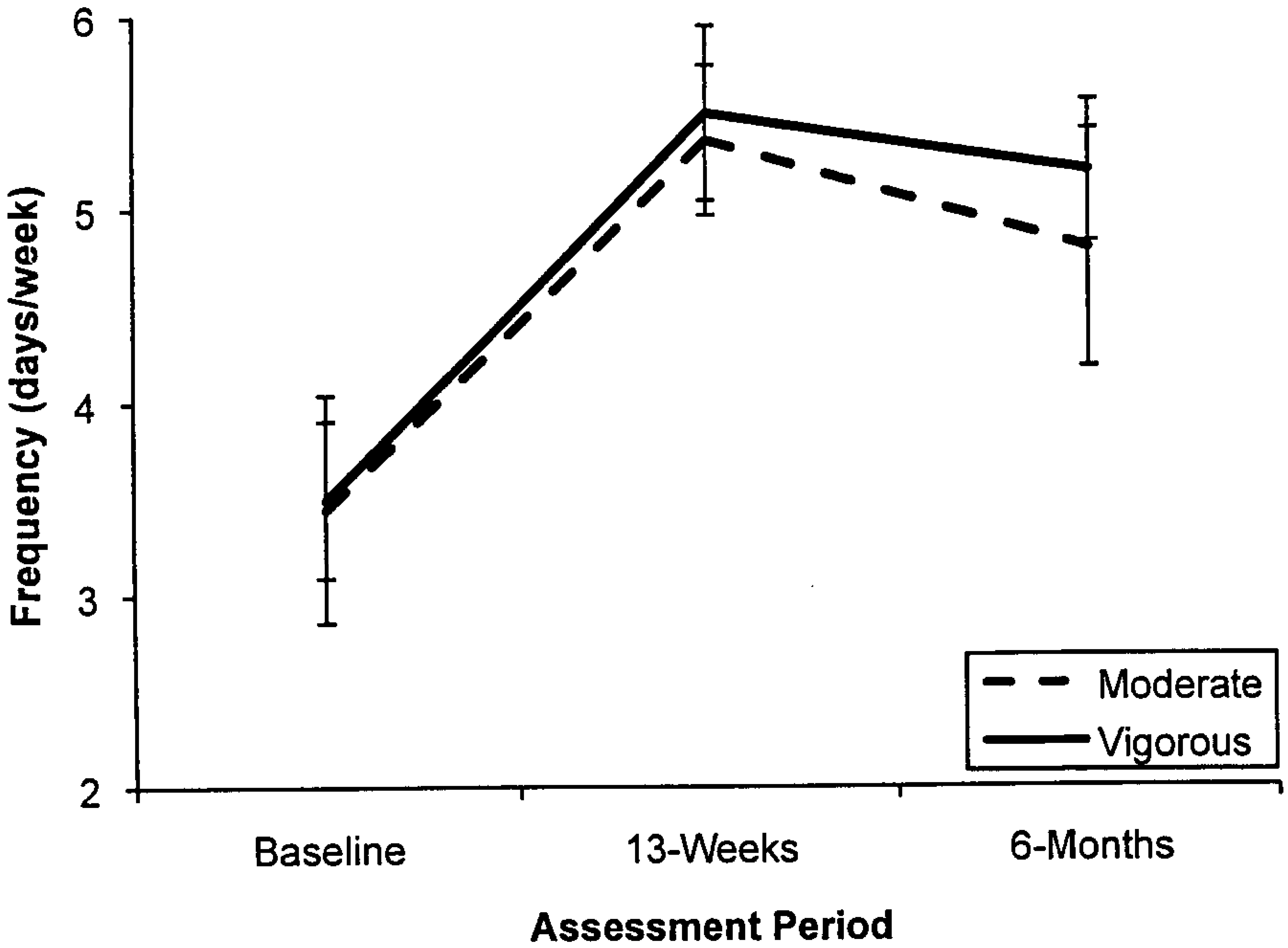

Figure 8. Mean frequency of physical activity per week at baseline, 13-weeks and 6-months. Error bars represent standard error.

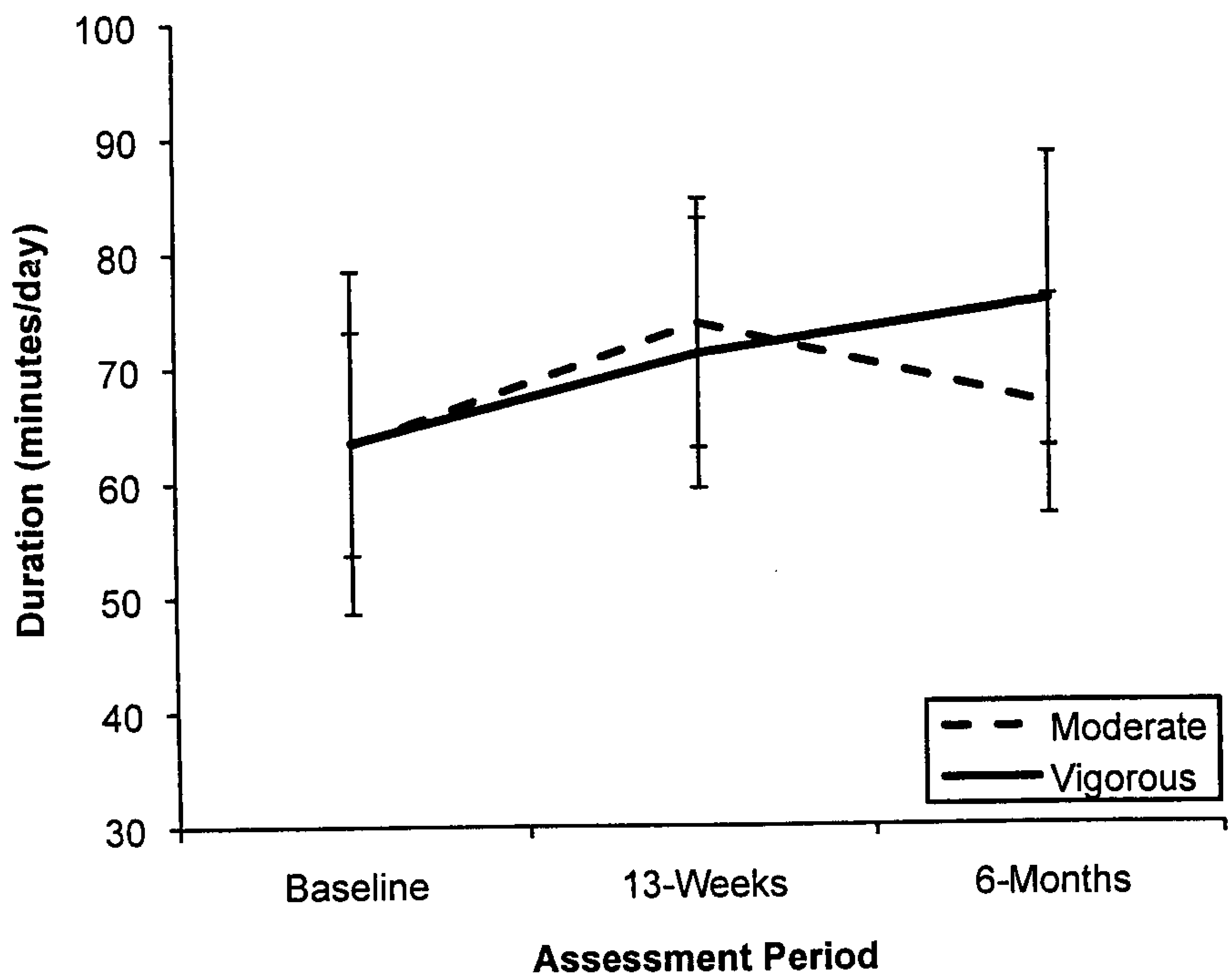

Figure 9. Mean duration of physical activity per day at baseline, 13-weeks and 6-months. Error bars represent standard error.

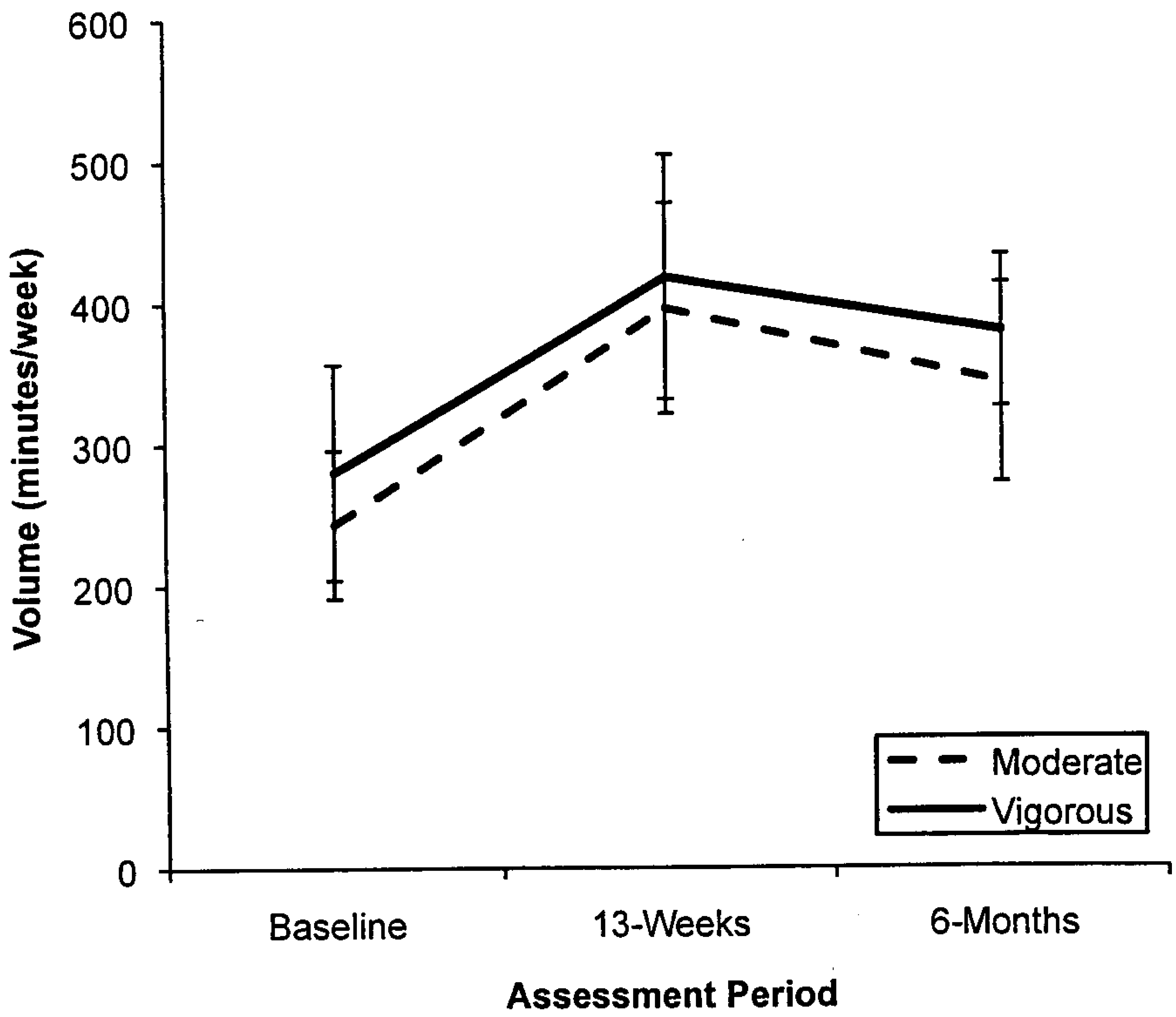

Figure 10. Mean volume of physical activity per week at baseline, 13-weeks and 6-months. Error bars represent standard error.

Secondary Outcomes

Effects of Exercise Intensity on Self-Efficacy

Physical activity self-efficacy. Hypothesis two was that participants in both conditions would report similar increases in self-efficacy to engage in light and moderate physical activity, but participants in the vigorous condition would report higher self-efficacy to engage in vigorous intensity physical activity as compared to participants in the moderate exercise condition at 13-weeks. To test this hypothesis, a 2 (Exercise Condition: moderate vs. vigorous) x 3 (Time: 2-, 6- and 13-week) repeated measures MANOVA was conducted on self-efficacy for light, moderate and vigorous physical activity. An overall main effect for time was found for self-efficacy for all three intensities of physical activity, $F(3,24) = 3.27$, $p < .05$, $\eta^2 = .48$. Follow-up univariate ANOVAs indicated there were significant increases over time for self-efficacy for light physical activity, $F(2, 52) = 8.19$, $p < .001$, $\eta^2 = .24$; moderate physical activity, $F(2, 52) = 5.23$, $p < .01$, $\eta^2 = .17$; and vigorous physical activity, $F(2, 52) = 8.49$, $p < .001$, $\eta^2 = .25$. However, contrary to hypothesis two, there was no main effect for exercise condition for vigorous physical activity self-efficacy, $F(1, 26) = 0.02$, $p = .89$, $\eta^2 = .01$, or Exercise Condition x Time interaction for vigorous physical activity self-efficacy, $F(2, 52) = 0.55$, $p = .58$, $\eta^2 = .02$, specifically. Therefore regardless of exercise condition, over time all participants reported significant increases in their self-efficacy for light, moderate and vigorous physical activity. Figure 11 displays these findings.

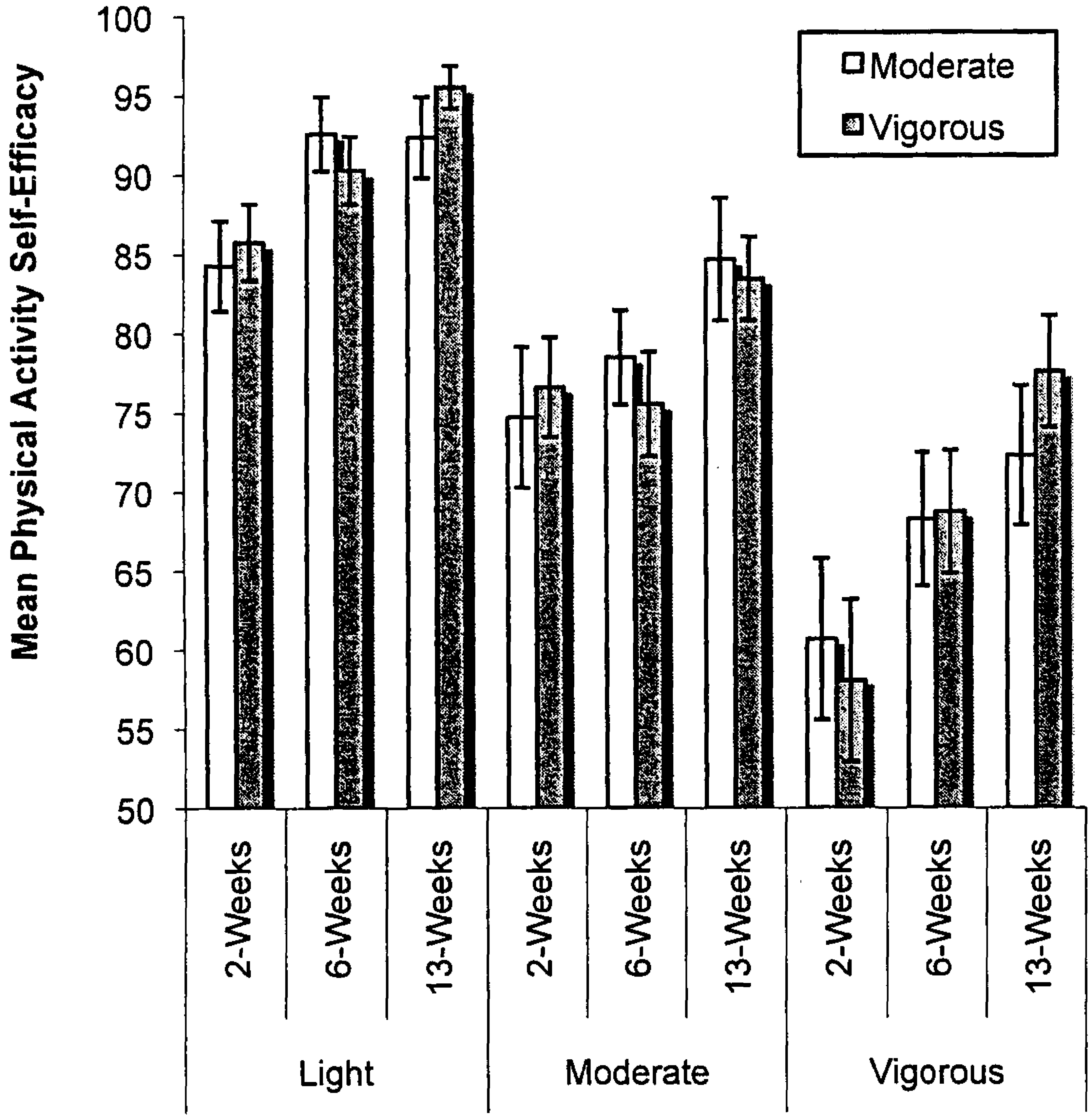

Figure 11. Mean light, moderate and vigorous physical activity self-efficacy at 2- 6- and 13-weeks for both conditions. Error bars represent standard error.

Goal setting self-efficacy. Both exercise conditions were expected to report similar increases in goal setting self-efficacy due to the GMCB intervention. This hypothesis was tested using a 2 (Exercise Condition: moderate vs. vigorous) x 3 (Time: 2-, 6- and 13-week) repeated measures ANOVA, with goal setting self-efficacy entered as the dependent variable. Contrary to hypothesis two, there was no main effect for time, $F(2,25) = .06$, $p = .94$, $\eta^2 = .01$. In addition, there was no main effect for exercise condition, $F(1,26) = 2.87$, $p =$

.10, η^2 = .10, or Exercise Condition x Time interaction, $F(2,25) = 0.21$, $p = .82$, η^2 = .02. Thus, over the course of the intervention there were no changes in goal-setting self-efficacy for either exercise condition. Figure 12 displays the means for the moderate and vigorous conditions at each time point.

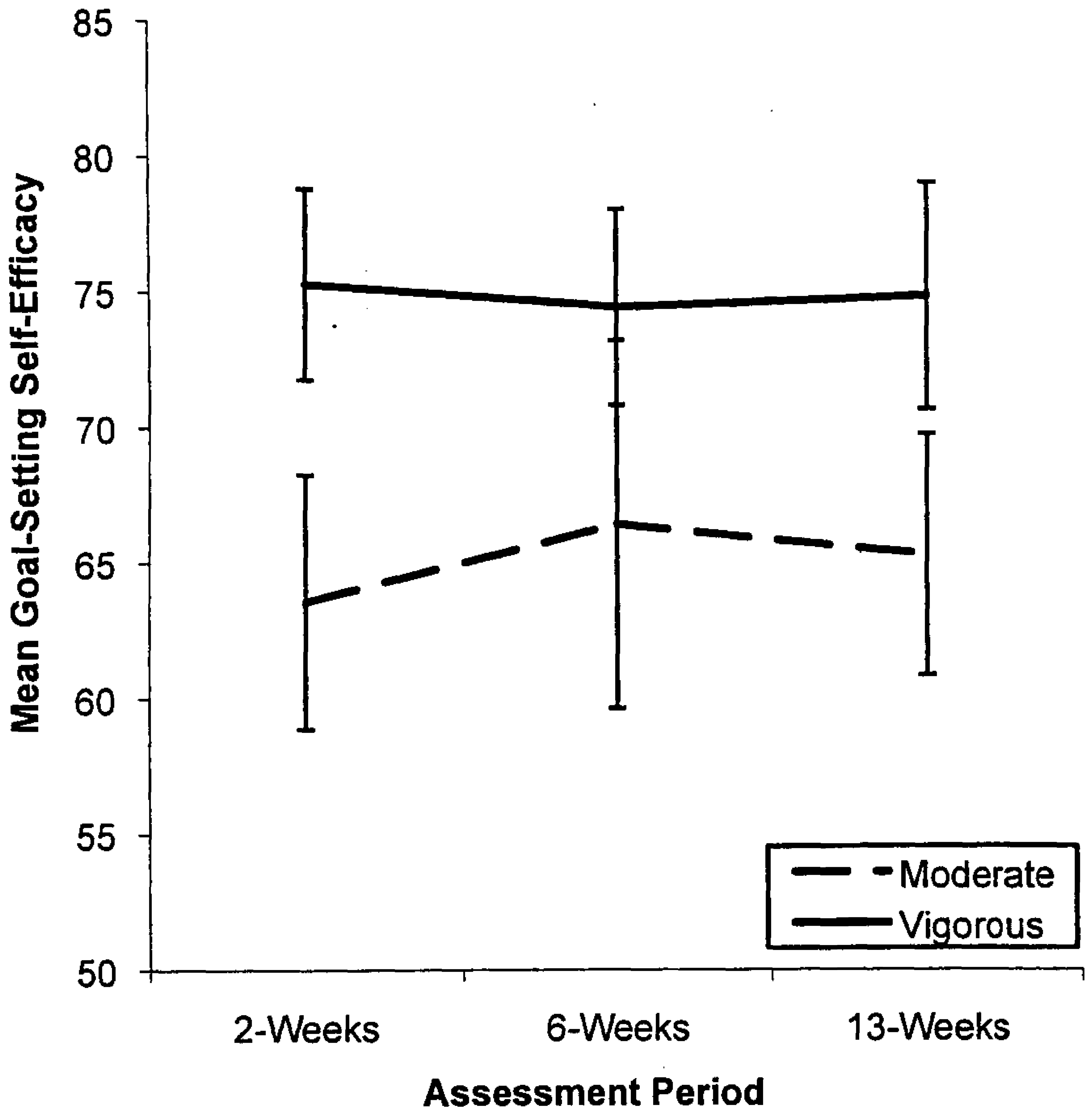

Figure 12. Mean goal-setting self-efficacy at 2-, 6- and 13-weeks for both conditions. Error bars represent standard error.

Planning self-efficacy. Both exercise conditions were expected to report similar increases in planning self-efficacy due to the GMCB intervention. This hypothesis was examined using a 2 (Exercise Condition: moderate vs. vigorous) x 3 (Time: 2-, 6- and 13-week) repeated measures ANOVA. Contrary to hypothesis two, the main effect for time was not significant, $F(2, 25) = 1.151$, $p = .24$, $\eta^2 = .11$. The main effect for group, $F(1,26) = 0.43$, $p = .52$, $\eta^2 = .02$, and Exercise Condition x Time interaction, $F(2,25) = 0.91$, $p = .42$, $\eta^2 = .07$, were also not significant. Over the course of the intervention there were no significant changes in planning self-efficacy for either exercise condition. Figure 13 displays the means for the moderate and vigorous conditions at each time point.

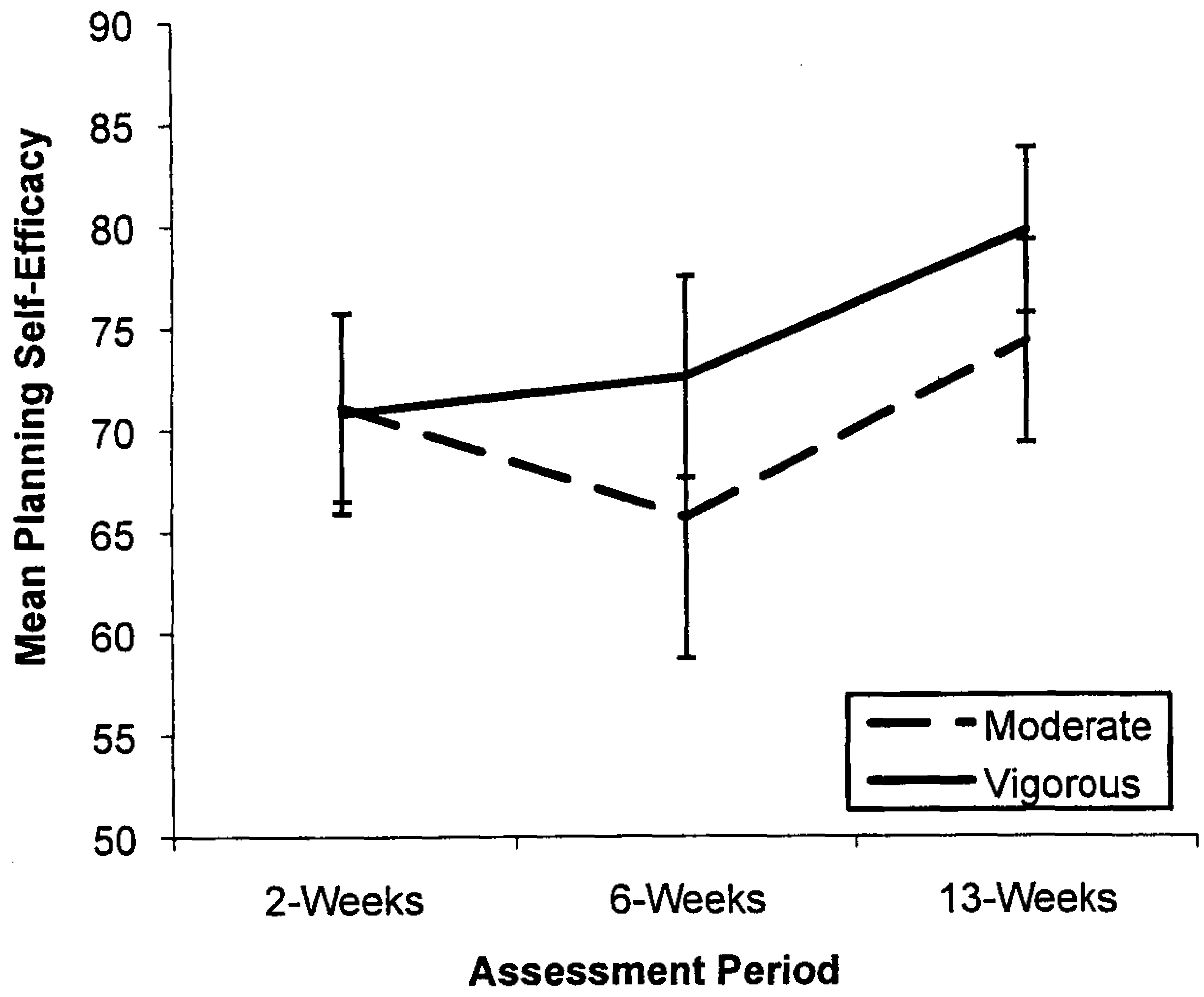

Figure 13. Mean planning self-efficacy at 2-, 6- and 13-weeks for both conditions. Error bars represent standard error.

Barrier self-efficacy. Both exercise conditions were expected to report similar increases in barrier self-efficacy due to the GMCB intervention. This hypothesis was examined using a 2 (Exercise Condition: moderate vs. vigorous) x 3 (Time: 2-, 6- and 13-weeks) repeated measures ANOVA. The main effect for time approached significance, $F(2,25) = 3.24$, $p = .056$, $\eta^2 = .21$. Examination of the estimated marginal means of barrier self-efficacy suggests that, regardless of exercise condition, participant's barrier self-efficacy increased over the course of the GMCB intervention ($M_{2\text{-}week} = 63.72$, $SE = 3.48$; $M_{6\text{-}week} = 68.57$, $SE = 3.28$; $M_{13\text{-}week} = 72.01$). There was no significant main effect for exercise condition, $F(1,26) = 0.90$, $p = .35$, $\eta^2 = .03$, or Time x Exercise Condition interaction, $F(2,25) = 0.56$, $p = .58$, $\eta^2 = .04$. Figure 14 displays these findings.

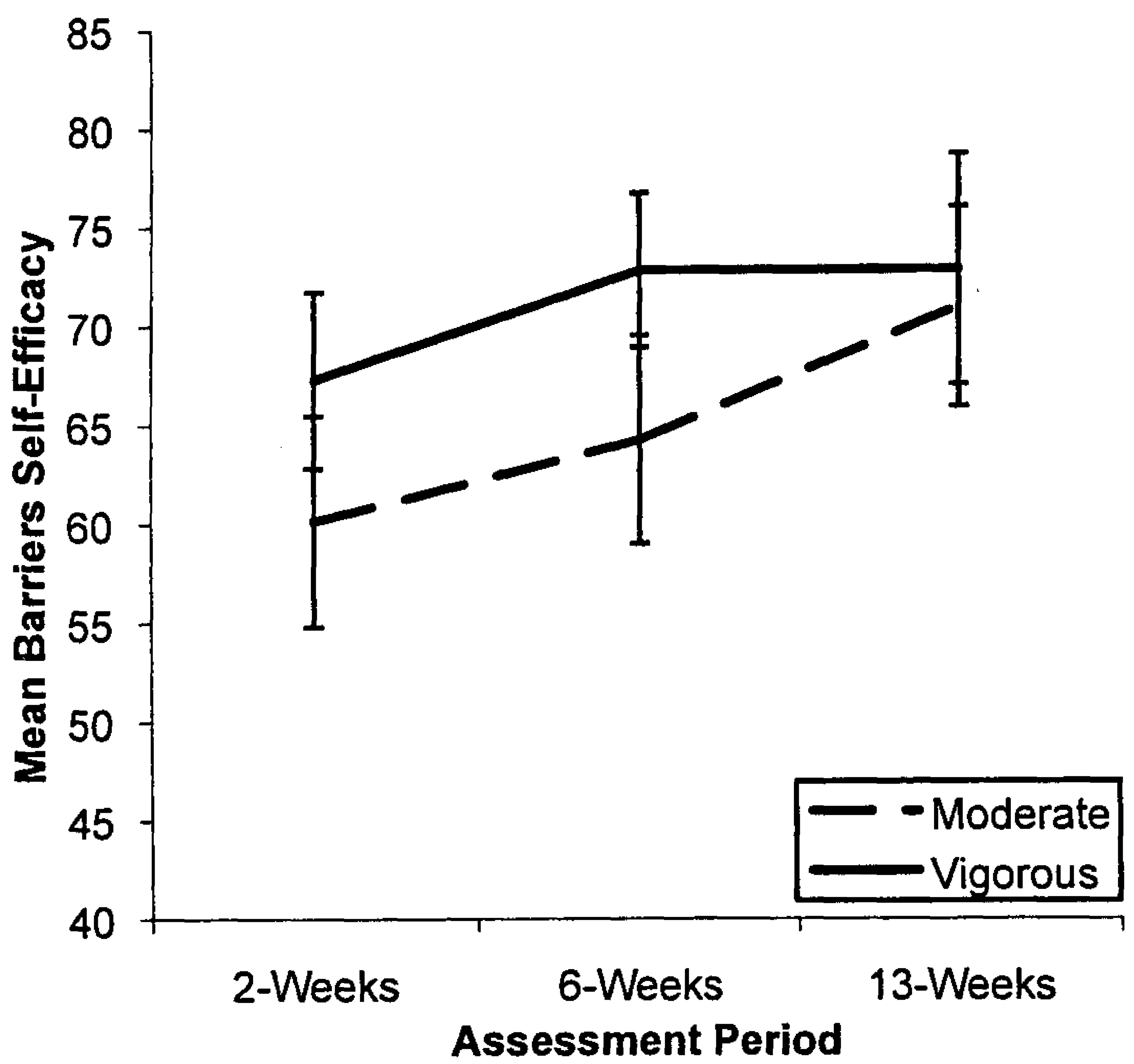

Figure 14. Mean barrier self-efficacy at 2-, 6- and 13-weeks for both conditions. Error bars represent standard error.

Effects of Exercise Intensity on Outcome Expectations

Hypothesis three pertained to anticipated changes in social, physical, and psychological outcome expectations over the course of the GMCB intervention.

Although performing a MANOVA including all three outcome expectation variables simultaneously would have been the most appropriate statistic to conduct, only 20 participants could be included in this analysis due to low value of outcome expectancy items. As such, we were underpowered to run the MANOVA statistic due to limited sample size. Instead, separate repeated measures ANOVAs were conducted for social, physical, and psychological outcome expectations.

Social outcome expectations. Hypothesis three posited that participants in the moderate condition would report higher social outcome expectations at the 13-week assessment compared to those in the vigorous condition. To test hypothesis three, a 2 (Exercise Condition: moderate vs. vigorous) x 3 (Time: baseline, 6 and 13-week) repeated measures ANOVA was run. There was no significant main effect for time, $F(2,17) = 1.28$, $p = .30$, $\eta^2 = .13$. Contrary to hypothesis three, the main effect for exercise condition was not significant, $F(1,18) = 0.78$, $p = .39$, $\eta^2 = .04$. In addition, the Time x Exercise Condition interaction was not significant, $F(2,17) = 2.10$, $p = .15$, $\eta^2 = .20$. Thus over the course of the intervention, regardless of exercise condition, social outcome expectations did not change. Figure 15 displays these findings.

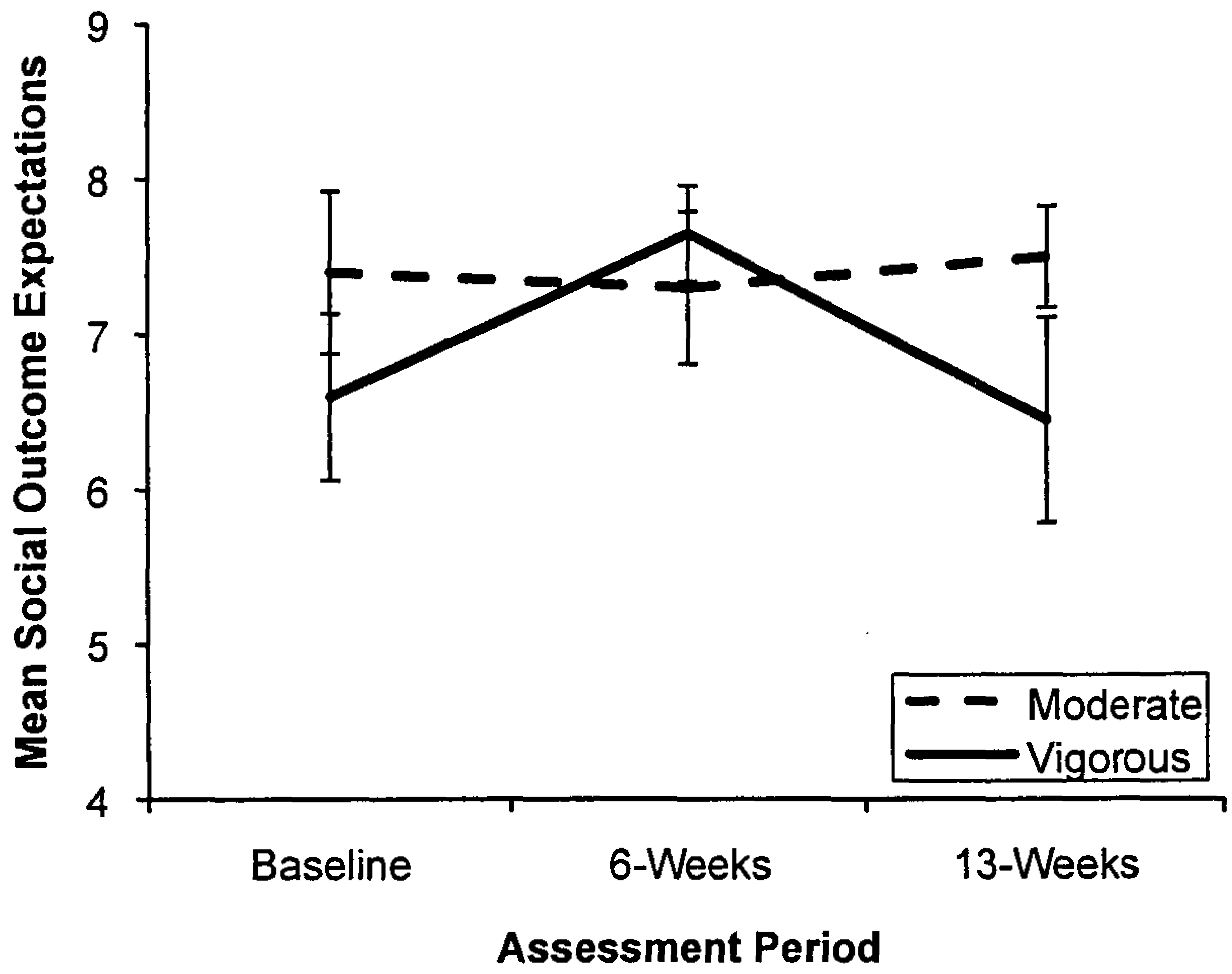

Figure 15. Mean social outcome expectations at baseline, 6- and 13-weeks for both conditions. Error bars represent standard error.

Physical outcome expectations. It was hypothesized that participants in the vigorous condition would report higher physical outcome expectations at 13-weeks compared to those in the moderate condition. In order to test hypothesis three, a 2 (Exercise Condition: moderate vs. vigorous) x 3 (Time: baseline, 6- and 13-week) repeated measures ANOVA was run. The main effect for time was not significant, $F(2,25) = 0.45$, $p = .64$, $\eta^2 = .04$. Contrary to hypothesis three, the main effect for exercise condition was not significant, $F(1,26) = 0.01$, $p = .95$, $\eta^2 = .00$. In addition, the Time x Exercise Condition interaction was not significant, $F(2,25) = 1.29$, $p = .29$, $\eta^2 = .09$. Thus over the course of the intervention, regardless of exercise condition, physical outcome expectations were maintained. Figure 16 displays these findings.

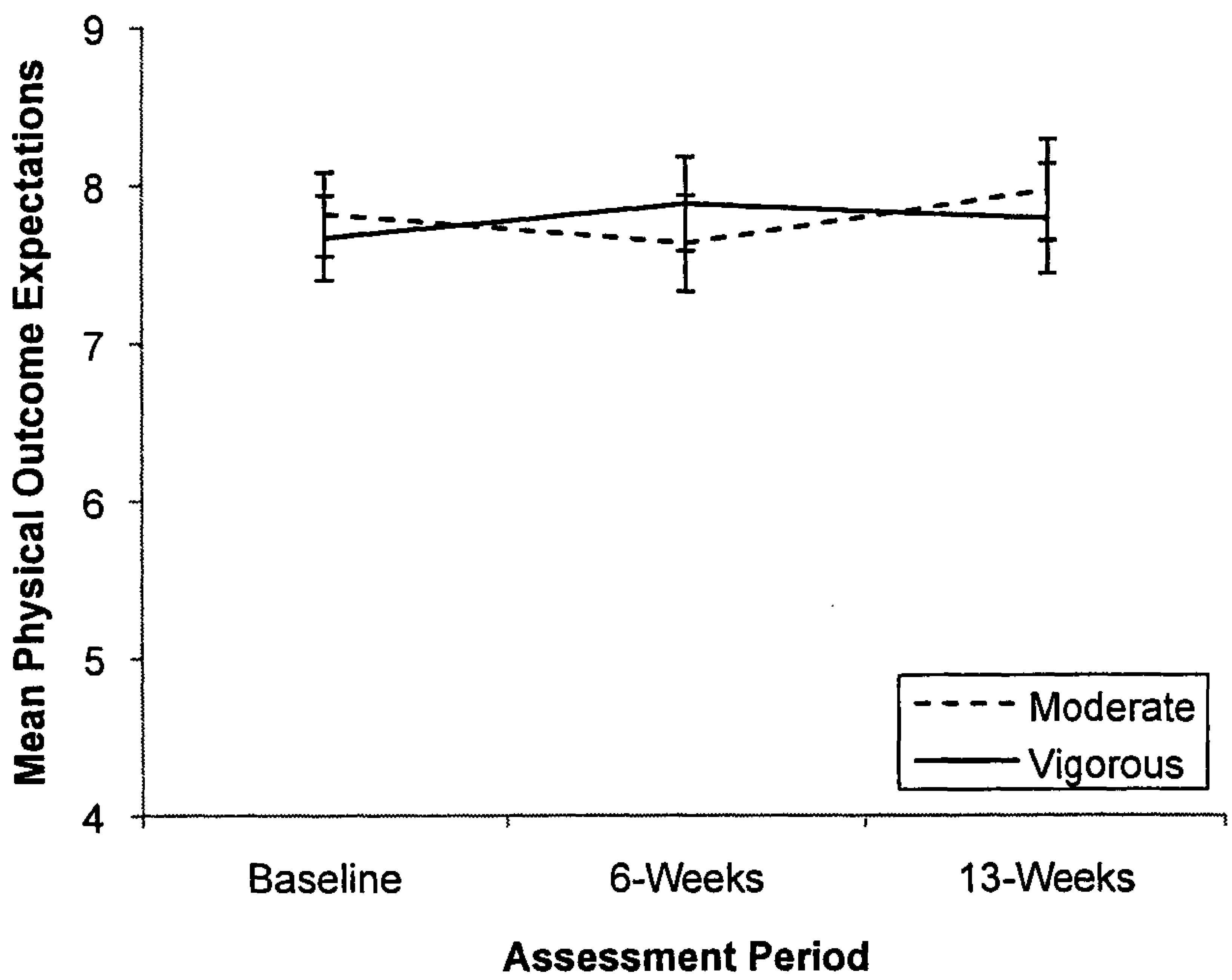

Figure 16. Mean physical outcome expectations at baseline, 6- and 13-weeks for both conditions. Error bars represent standard error.

Psychological outcome expectations. It was hypothesized that participants in the moderate condition would report higher psychological outcome expectations at the 13-week assessment compared to those in the vigorous condition. Therefore, to test hypothesis three, a 2 (Exercise Condition: moderate vs. vigorous) x 3 (Time: baseline, 6- and 13-week) repeated measures ANOVA was run. There was no significant main effect for time, $F(2,25) = 0.64$, $p = .54$, $\eta^2 = .05$. Contrary to hypothesis three, the main effect for exercise condition was not significant, $F(1,26) = 0.38$, $p = .54$, $\eta^2 = .01$. In addition, the Time x Exercise Condition interaction was not significant, $F(2,25) = 0.48$, $p = .63$, $\eta^2 = .04$. Thus over the course of the intervention, regardless of exercise condition, psychological outcome expectations were maintained. Figure 17 displays these findings.

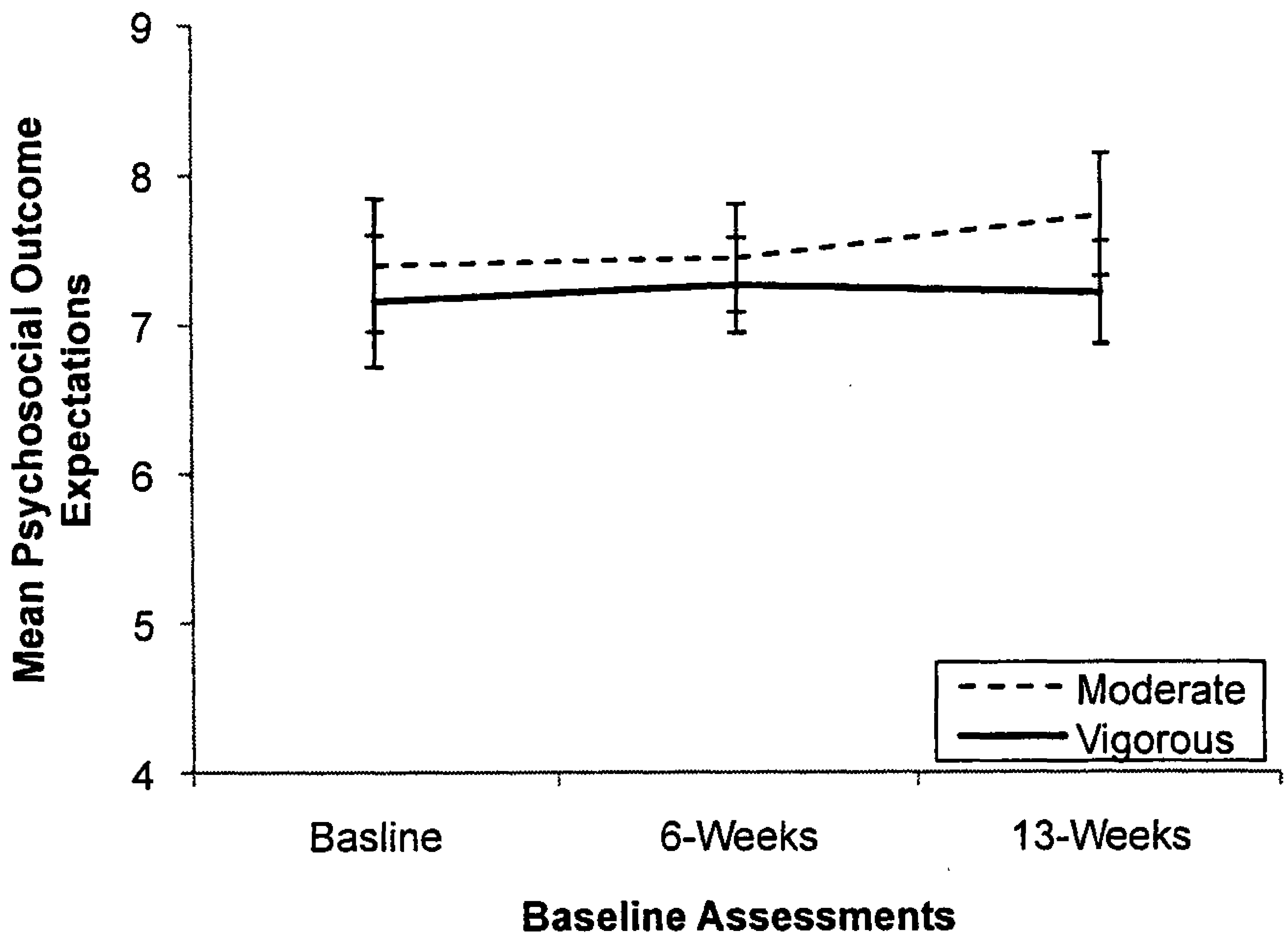

Figure 17. Mean psychosocial outcome expectations at baseline, 6- and 13-weeks for both conditions. Error bars represent standard error.

Effects of Exercise Intensity on Enjoyment

It was hypothesized that compared to participants in the vigorous condition, participants in the moderate condition would report greater exercise enjoyment. In order to test hypothesis four, a 2 (Exercise Condition: moderate vs. vigorous) x 4 (Time: baseline, 2-, 6- and 13-week) repeated measures ANOVA was conducted. Exercise enjoyment was entered as the sole dependent variable. There was a significant main effect for time, $F(3, 24) = 9.33$, $p < .001$, $\eta^2 = .54$. Contrary to hypothesis four, there was no main effect for exercise condition, $F(1,26) = 0.23$, $p = .64$, $\eta^2 = .01$, or Time x Exercise Condition interaction, *F*(3,24) = 0.14, *p* = .94, η^2 = .02. Both exercise conditions enjoyed physical activity similarly over the intervention. Figure 18 displays the mean physical activity enjoyment for the moderate and vigorous conditions at each time point.

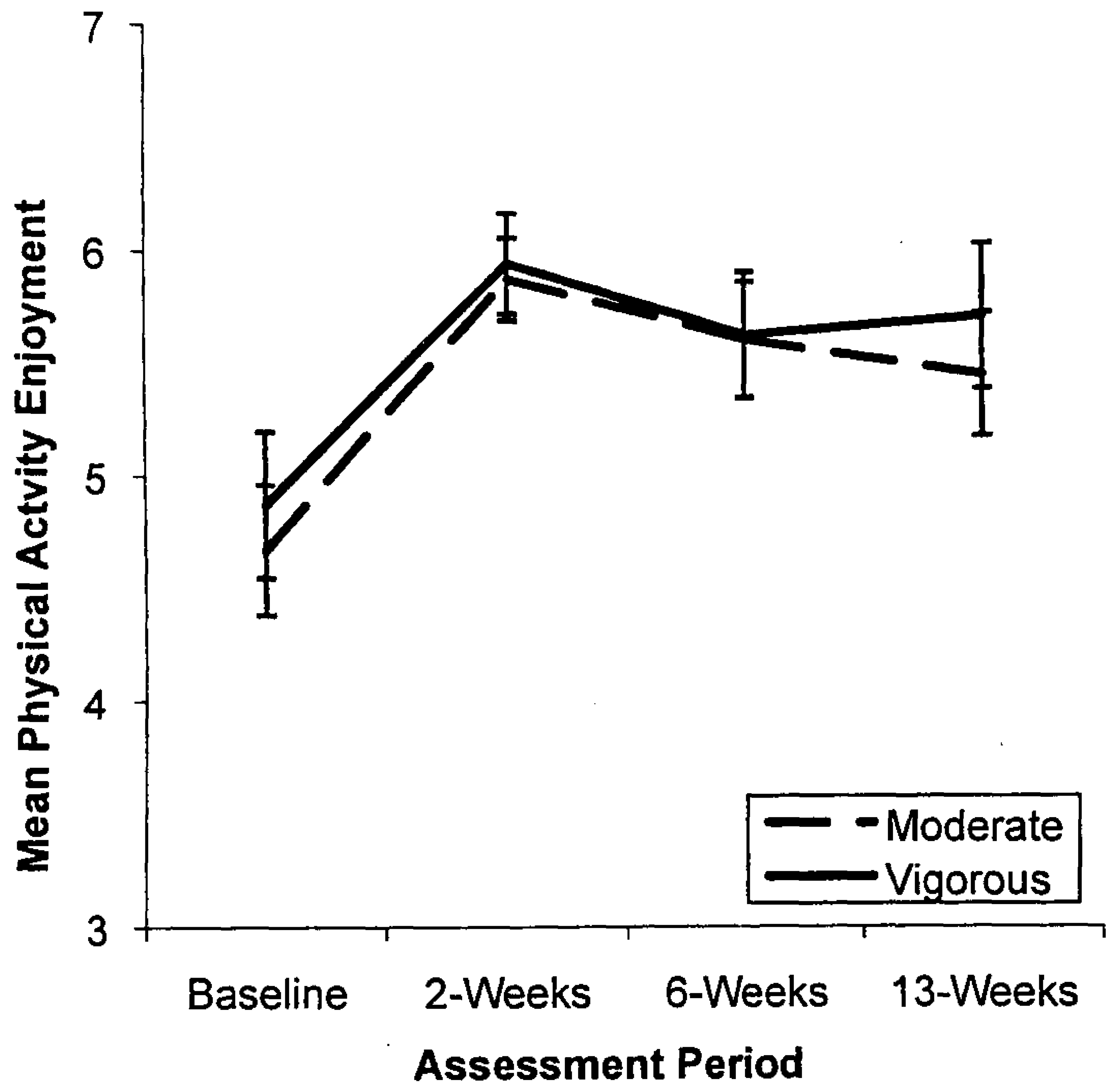

Figure 18. Mean physical activity enjoyment at baseline, 2-, 6- and 13-weeks for both conditions. Error bars represent standard error.

Effects of Exercise Intensity on Satisfaction

Hypothesis five posited that, compared to participants in the moderate condition, participants in the vigorous condition would report greater satisfaction with outcomes, current state, and changes from the REACH program at 13-weeks. In order to test this hypothesis, a 2 (Exercise Condition: moderate vs. vigorous) x 3 (Time: baseline, 6- and 13-week) repeated measures MANOVA was run on all three types of satisfaction. There was an overall main effect for time, $F(6, 21) = 7.75$, $p < .001$, $\eta^2 = .69$. Contrary to hypothesis five, there was no main effect for exercise condition, $F(3, 24) = 0.14$, $p = .93$, $\eta^2 = .02$. In addition, the Time x Exercise Condition interaction was not significant, $F(3, 21) = 0.34$, $p = .91$, $\eta^2 = .09$.

Follow-up univariate ANOVAs indicated that over time, there were significant increases in outcome satisfaction, $F(2, 52) = 19.50$, $p < .001$, $\eta^2 = .43$, and current state satisfaction, $F(2, 52) = 15.81$, $p < .001$, $\eta^2 = .38$, but not for satisfaction with changes resulting from the REACH program, $F(2, 52) = 1.15$, $p = .33$, $\eta^2 = .04$. Thus over the course of the intervention, participants in both exercise conditions were more satisfied with the outcomes pertaining to physical activity and their current physical state, but did not report differences in their satisfaction with changes resulting from the REACH program over the 12-weeks. Figure 19, 20, and 21 display mean satisfaction with outcomes, current state, and with changes from the REACH program for the moderate and vigorous conditions at each time point, respectively.

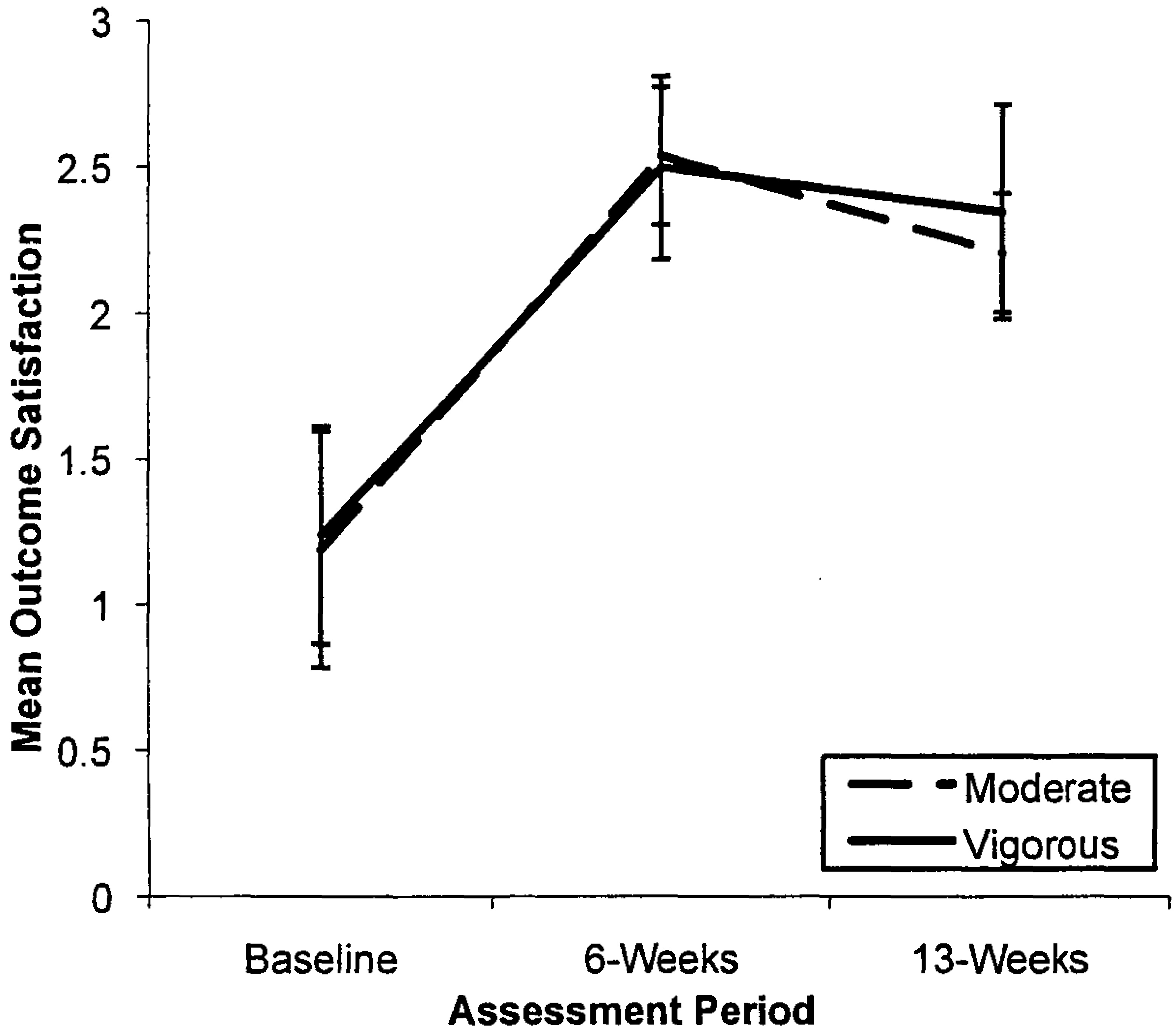

Figure 19. Mean outcome satisfaction at baseline, 6- and 13-weeks for both conditions. Error bars represent standard error.

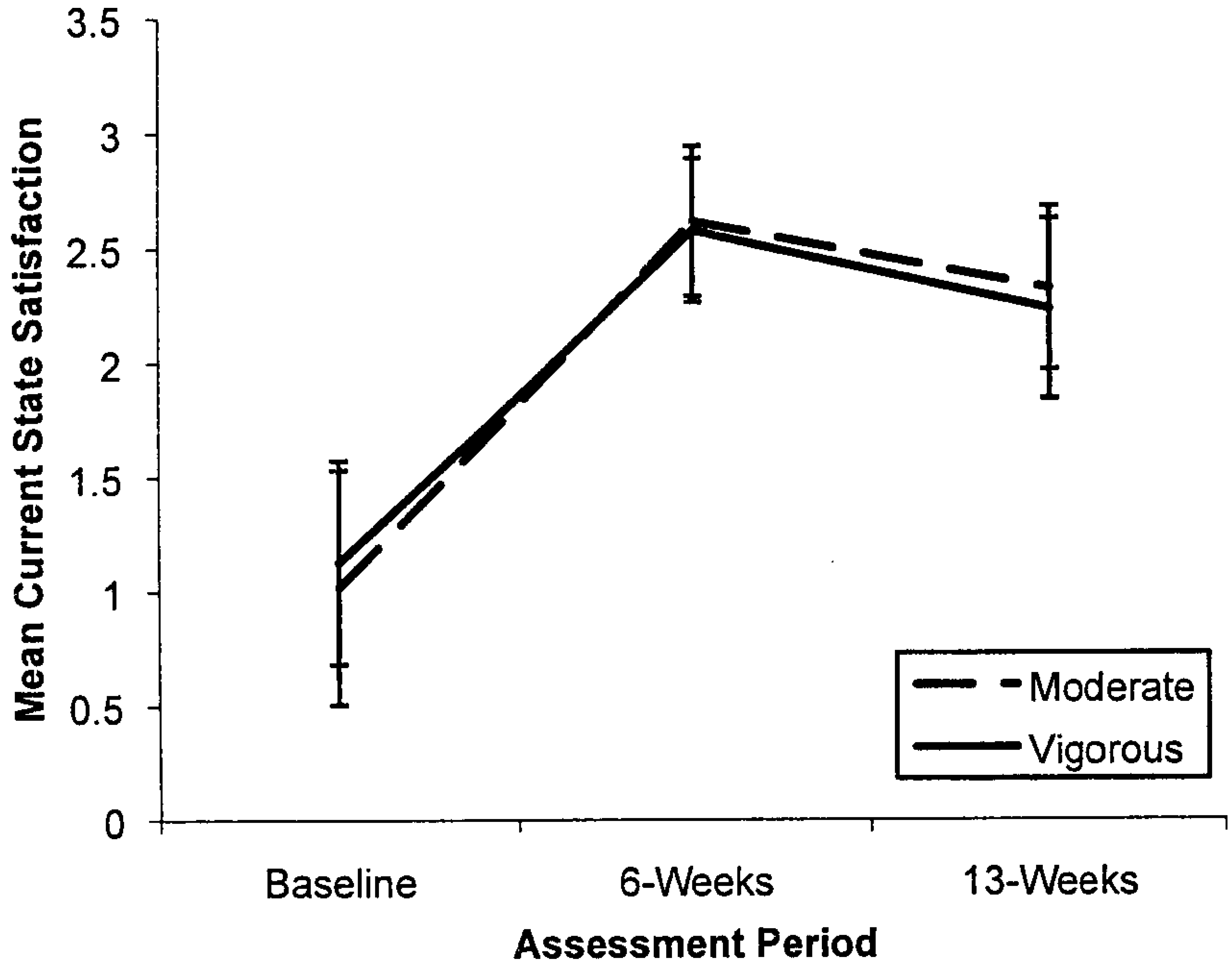

Figure 20. Mean current state satisfaction at baseline, 6- and 13-weeks for both conditions. Error bars represent standard error.

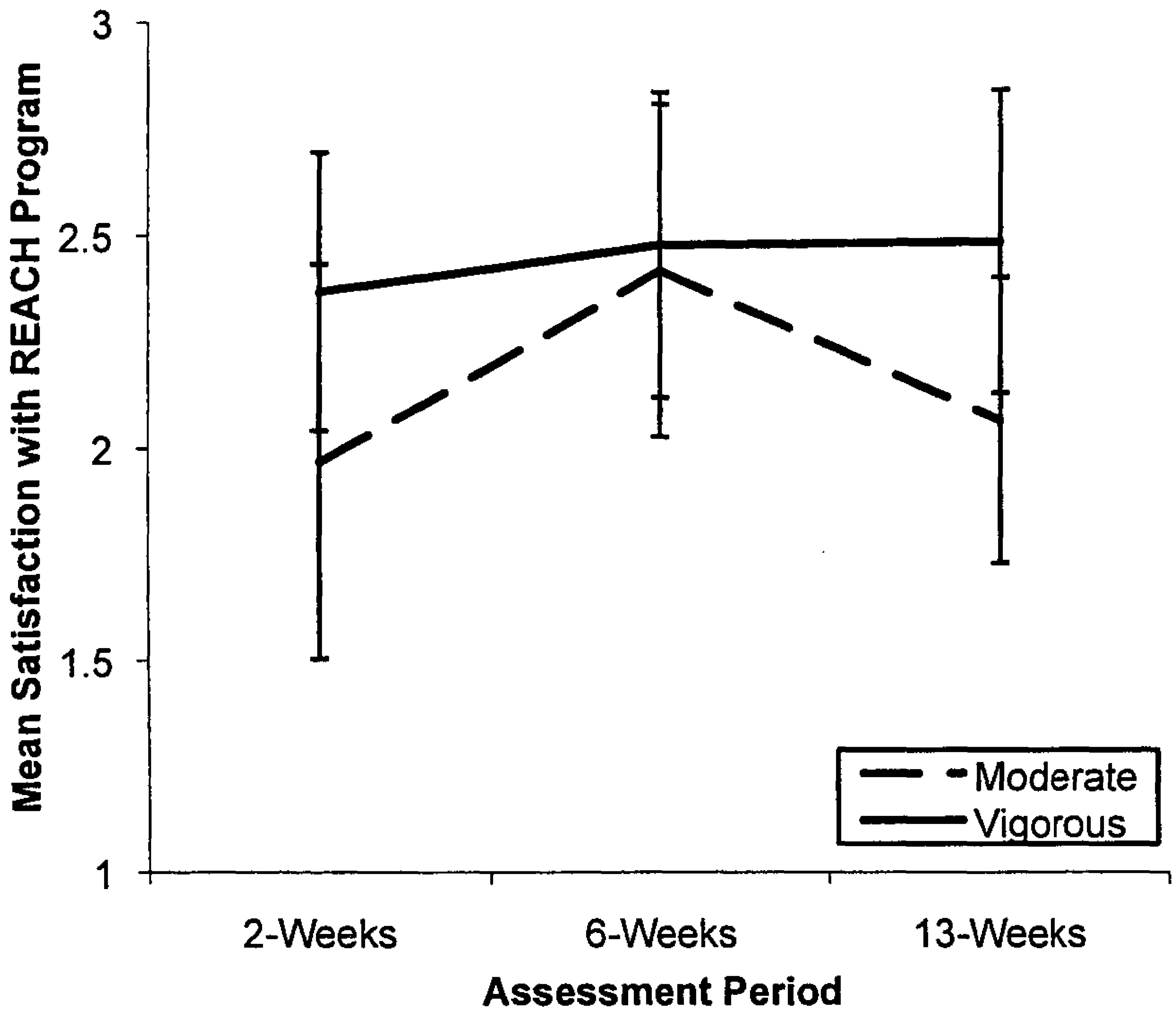

Figure 21. Mean satisfaction with the REACH program at 2-, 6- and 13-weeks for both conditions. Error bars represent standard error.

Effects of Exercise Intensity on Body Composition

As outlined in hypothesis six, it was anticipated that at 13-weeks, participants in both conditions would experience improvements in body composition from baseline, however participants in the vigorous condition were hypothesized to experience even greater improvements than those in the moderate condition. A 2 (Exercise Condition: moderate vs. vigorous) x 2 (Time: baseline and 13-week) repeated measures MANOVA was run to examine the effects of exercise intensity on percent body fat, lean mass, fat free mass and z-BMI. Overall the main effect for time was significant, $F(4, 25) = 7.56$, $p < .001$, $\eta^2 = .55$, providing partial support for this hypothesis. Follow-up univariate ANOVAs indicated that there were significant main effects for time for the following variables: percent body fat, $F(1,28) = 24.91$, $p < .001$, $\eta^2 = .47$, fat free mass, $F(1,28) = 10.16$, $p < .01$, $\eta^2 = .27$, and z BMI, $F(1,28) = 4.28$, $p < .05$, $\eta^2 = .11$. Examination of the estimated marginal means suggests that percent body fat decreased, fat free mass increased, and BMI decreased over time. Change in muscle mass did not reach standard levels of significance, $F(1,28) = 2.86$, $p = .10$, $\eta^2 = .09$. The overall main effect for exercise condition, $F(4, 25) = 0.37$, $p = .83$, $\eta^2 = .06$, and Time x Exercise Condition interaction were not significant, $F(4, 25) = 1.94$, $p = .14$, $\eta^2 = .24$, suggesting that participants in the vigorous condition did not improve upon body composition variables to a greater extent than did participants in the moderate condition. See Table 10 for percent change for each variable. Figure 22 displays these findings.

Table 10

Percent Change for Body Composition Variables from Baseline to 13-weeks

Variable	Moderate Intensity Exercise Condition (n = 14)	Vigorous Intensity Exercise Condition (n = 16)
% Body fat	3.43%	3.00%
Lean mass	2.05%	1.12%
Fat free mass	2.41%	1.93%
BMI	2.36%	0.01%

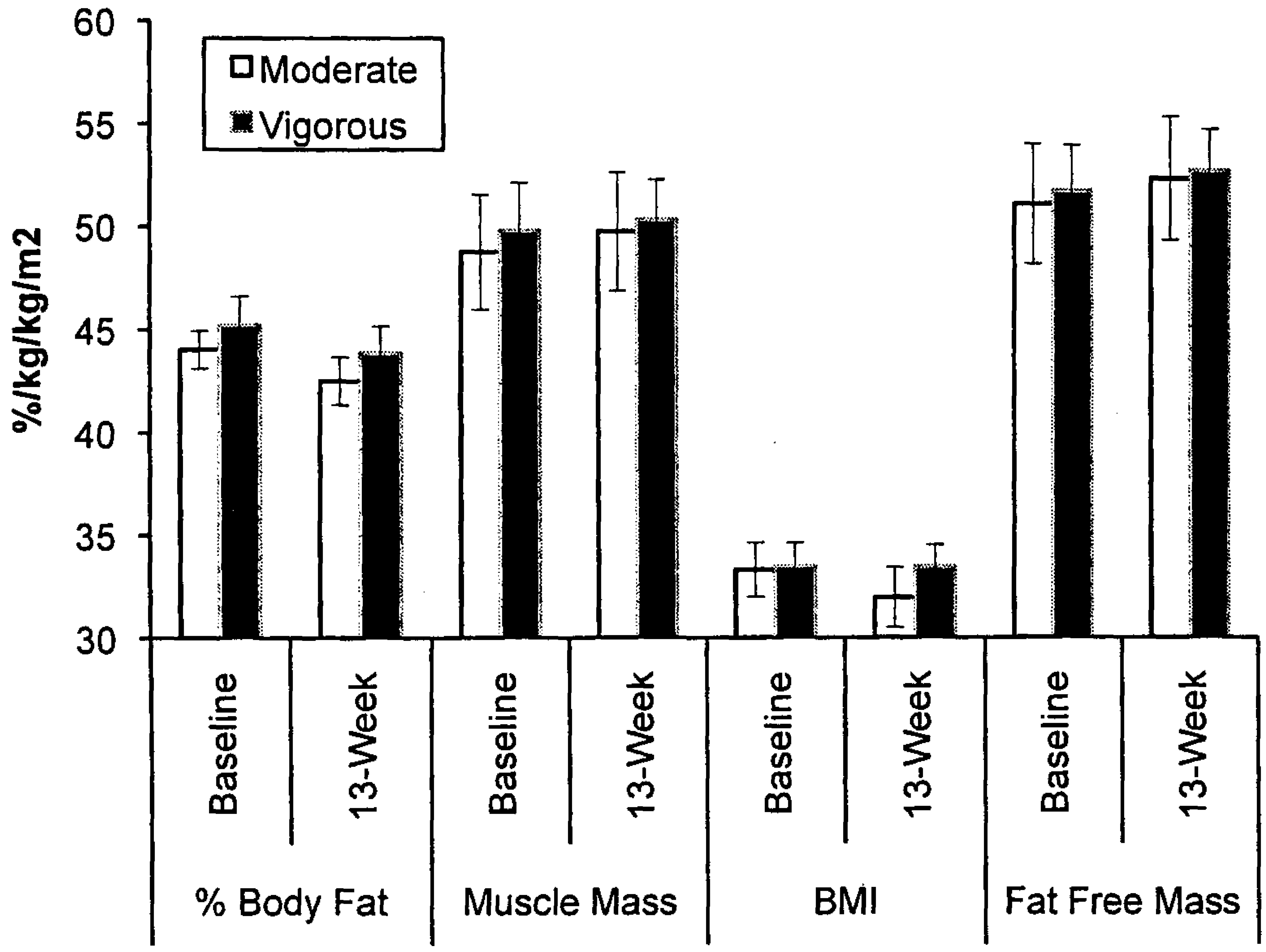

Figure 22. Mean body composition at baseline and 13-weeks. Variables measured in mass are in kilograms. Error bars represent standard error.

Effects of Exercise Intensity on Fitness

Change in strength. As outlined in hypothesis six, it was anticipated that at 13-weeks, participants in both conditions would experience improvements in strength from baseline, however participants in the vigorous condition were hypothesized to experience even greater improvements than those in the moderate condition. A 2 (Exercise Condition: moderate vs. vigorous) x 2 (Time: baseline and 13-week) repeated measures MANOVA was used to examine changes in chest and leg strength before and after the 12-week exercise intervention. Overall the main effect for time was significant, $F(2,27) = 15.03$, $p <$

.001, $\eta^2 = .53$; however the main effects for exercise condition, $F(2,27) = 0.16$, $p = .86$, $\eta^2 = .01$, and Time x Exercise Condition interaction, $F(2,27) = 0.88$, $p = .43$, $\eta^2 = .06$, were not significant. Follow-up univariate ANOVAs indicated that regardless of exercise condition, compared to baseline, at the 13-week assessment participants had significant improvements in chest strength, $F(1,28) = 18.41$, $p < .001$, $\eta^2 = .40$, and leg strength, $F(1,28) = 19.85$, $p < .001$, $\eta^2 = .42$. Therefore, after the 12-week intervention, participants in both conditions had similar improvements in both chest and leg strength. See Table 11 for percent change for each variable. Figures 23 and 24 display the baseline and 13-week means for both the moderate and vigorous conditions.

Table 11

Percent Change for Chest and Leg Strength from Baseline to 13-weeks

Variable	Moderate Intensity Exercise Condition (n = 14)	Vigorous Intensity Exercise Condition (n = 16)
Chest	11.32%	9.29%
Leg	36.40%	19.19%

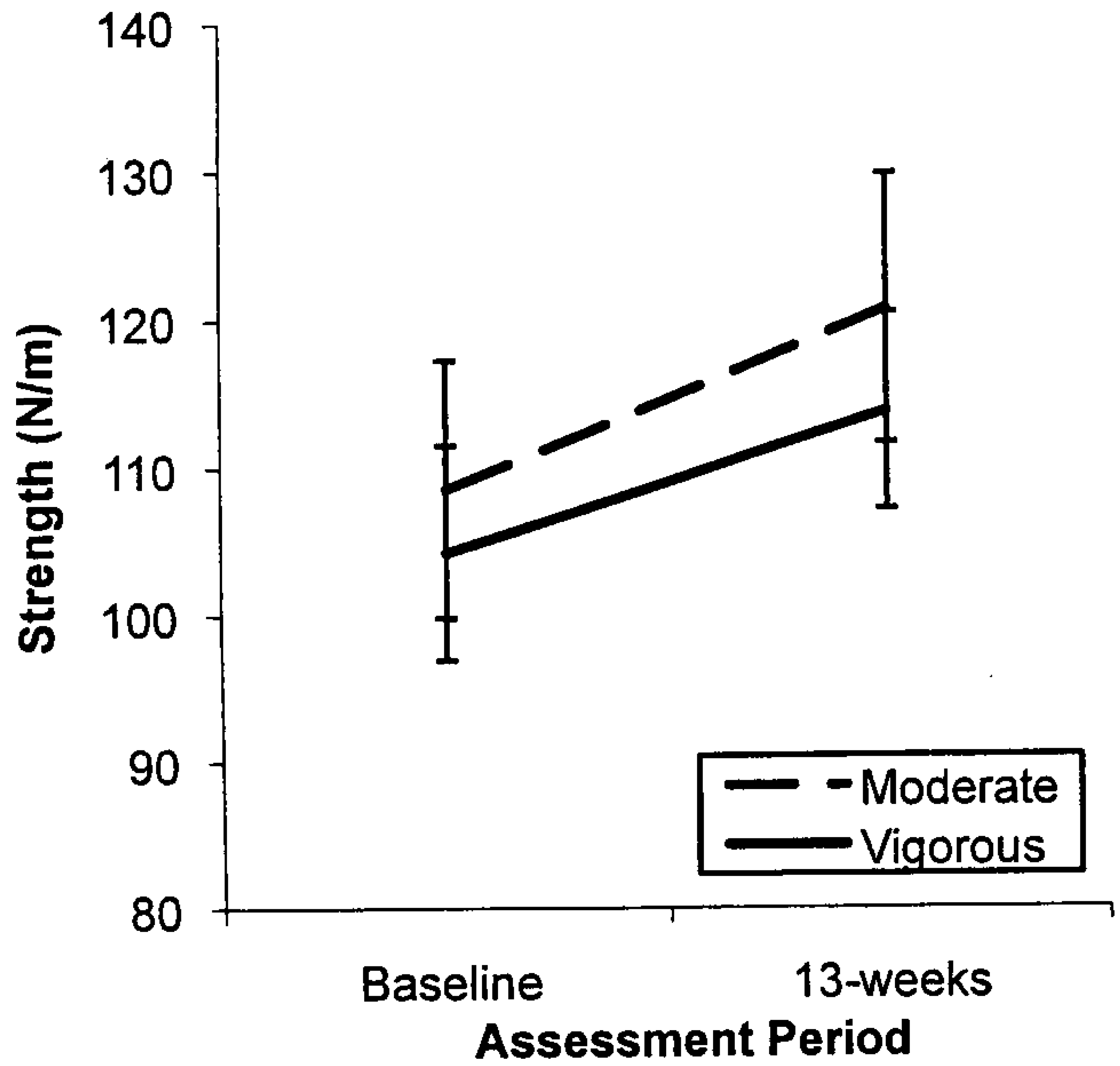

Figure 23. Mean chest strength at baseline and 13-weeks. Error bars represent standard error.

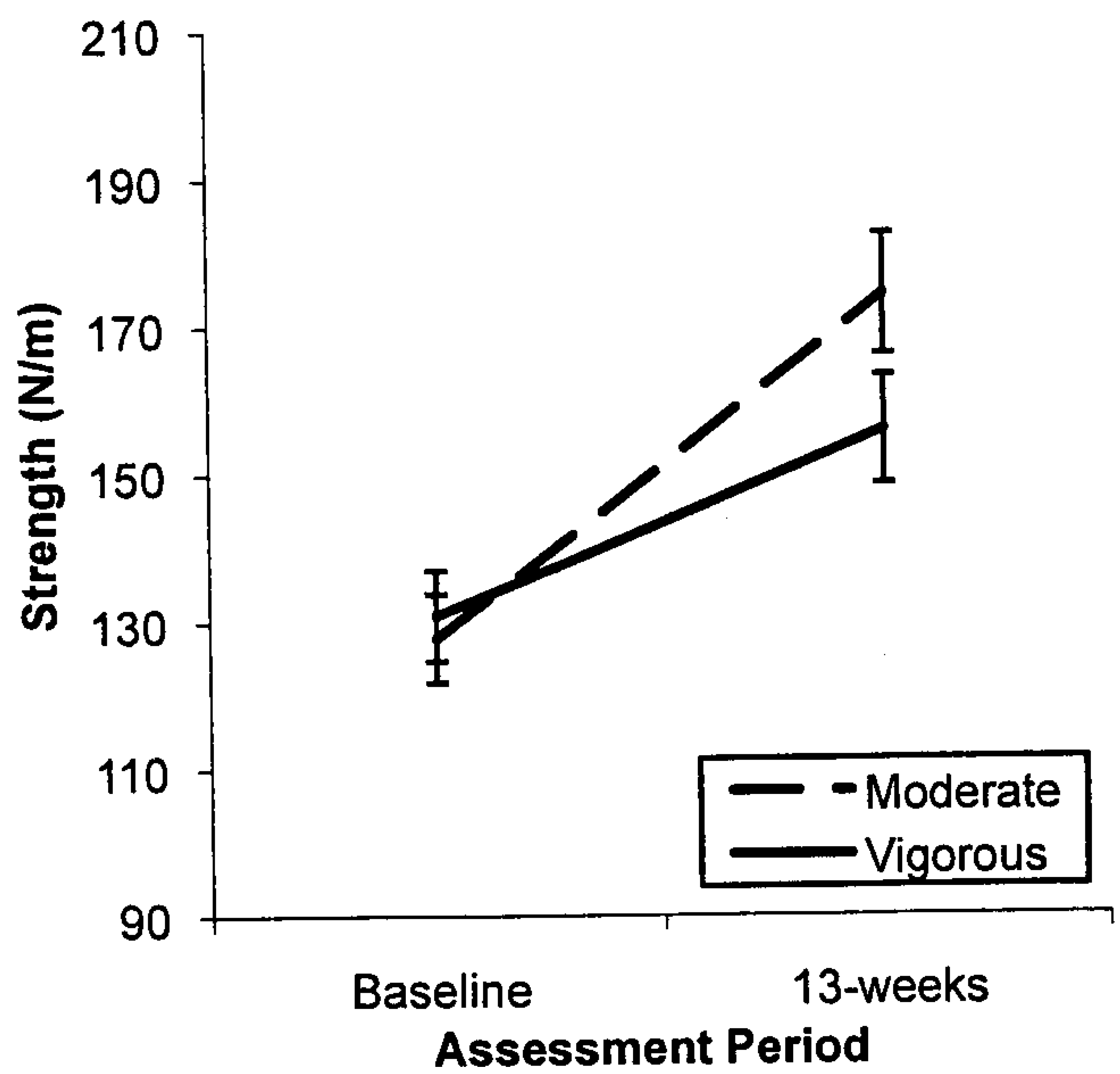

Figure 24. Mean leg strength at baseline and 13-weeks. Error bars represent standard error.

Changes in aerobic fitness. As outlined in hypothesis six, it was anticipated that at 13-weeks, participants in both conditions would experience improvements in aerobic fitness from baseline, however participants in the vigorous condition were hypothesized to experience even greater improvements than those in the moderate condition. A 2 (Exercise Condition: moderate vs. vigorous) x 2 (Time: baseline and 13-weeks) repeated measures ANOVA was used to examine changes in aerobic fitness between baseline and 13-weeks. In order to ensure only participants who achieved their VO_2 max were included in the analyses, participants were excluded from the analyses if their heart rate did not reach at least 85% of their predicted maximum heart rate, and if their respiratory exchange ratio did not reach at least 0.95 (Gutin et al., 2002; Gutin et al., 2005). The main effect for time was significant, $F(1,12) = 13.34$, $p < .001$, $\eta^2 = .53$, which partially supported our hypothesis. However, the main effect for exercise condition, $F(1,12) = 0.28$, $p = .61$, $\eta^2 = .02$, and Time x Exercise Condition interaction, $F(1,12) = 0.64$, $p = .44$, $\eta^2 = .05$, were not significant. Figure 25 displays these findings.

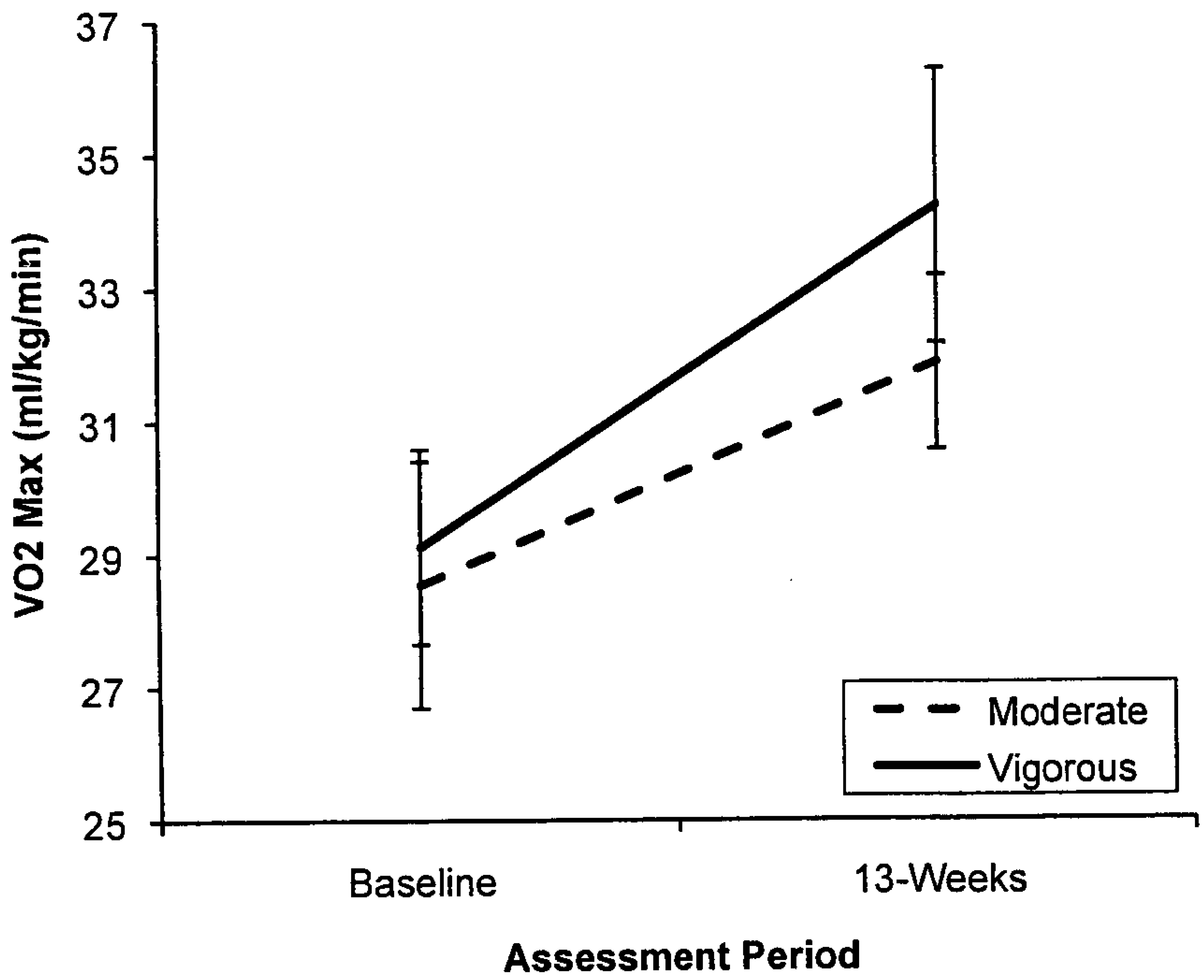

Figure 25. Mean VO_2 max (ml/kg/min) at baseline and 13-weeks for both conditions. Error bars represent standard error.

Psychosocial Predictors of Long-term Physical Activity

Hypothesis seven posited that the psychosocial variables self-efficacy, outcome expectations, enjoyment and satisfaction at 6- and 13-weeks would predict volume of physical activity at 13-weeks and 6-months, respectively. Volume of physical activity was chosen as it was thought to most accurately represent physical activity participants engaged in and allow comparison to physical activity recommendations for youth. The specific time points were selected to a) examine if social cognitions after just 6-weeks of the intervention could predict independent physical activity at 13-weeks, and b) examine if social cognitions immediately after the entire 12-week intervention could predict 6-month independent physical activity. Sample size precluded the examination of all variables in one prediction model. Consequently, variables pertaining to self-efficacy, outcome expectations, enjoyment and satisfaction were tested in separate models for each time point.

Prediction of 13-week and 6-month volume of physical activity by 6- and 13-week self-efficacy. Correlations between 6- and 13-week self-efficacy and 13-week and 6-month volume of physical activity can be found in Table 12. To determine if physical activity, barrier, planning and goal setting self-efficacy at 6-weeks would predict volume of physical activity at 13-weeks, a linear regression analysis was conducted. All four subscales of 6-week self-efficacy were entered in as one step in the model to predict 13-week volume of physical activity. In addition to being underpowered to include the individual subscales of physical activity self-efficacy (i.e., light, moderate, and vigorous physical activity self-efficacy), the combination of intensities of physical activity self-efficacy was thought to be more appropriate in the prediction of overall volume of physical activity. The overall model for 6-week self-efficacy predicting 13-week volume of physical activity was not significant, R^2 = .11 (R^2_{adj} = -.05), $F(4, 23)$ = 0.70, p = .60 (see Table 13).

To determine if physical activity, barrier, planning and goal setting self-efficacy at 13-weeks would predict volume of physical activity at 6-months, a linear regression analysis was conducted. All four subscales of 13-week self-efficacy were entered in as one step in the model to predict 6-month volume of physical activity. The overall model for 13-week self-efficacy predicting 6-month volume of physical activity was not significant R^2 = .05 (R^2_{adj} = -.16), $F(4, 18)$ = 0.22, p = .92 (see Table 13). These findings suggest that self-efficacy did not predict short-term (13-weeks) or long-term (6-months) volume of physical activity.

Table 12

Means, Standard Deviations and Correlations between Self-efficacy and Volume of Physical Activity

	M	*SD*	1	2	3	4	5
6-week self-efficacy predicting 13-week volume of physical activity							
1. Volume	441.96	298.82	-	-.10	-.13	.23	.02
2. Goal setting	70.21	20.28		-	.94***	.54	.44**
3. Planning	69.22	22.50			-	.60***	.38*
4. Barrier	68.67	17.67				-	.46**
5. Physical activity	80.02	14.75					-
13-week self-efficacy predicting 6-month volume of physical activity							
1. Volume	357.43	218.66	-	-.02	-.08	-.19	.03
2. Goal setting	69.50	17.83		-	.74***	.55**	.54**
3. Planning	78.45	17.71			-	.64***	.59**
4. Barrier	72.76	19.28				-	.05
5. Physical activity	84.85	15.97					-

Note. Volume = volume of physical activity per week (minutes/week). Self-efficacy was measured on a 0 (*Absolutely not confident*) to 100 percent (*Absolutely confident*) scale. Outcome expectations were measured on a 1 (*very unlikely*) to 9 (*very likely*) scale. Satisfaction was measured on a -4 (*very unsatisfied*) to 4 (*very satisfied*) scale. Enjoyment was measured on a 1 (*I hate it*) to 7 (*I enjoy it*) scale.

* $p < .05$; ** $p < .01$; *** $p < .001$.

Table 13

Multiple Regression Analysis for Self-efficacy to Predict Volume of Physical Activity

6-week self-efficacy predicting 13-week volume of physical activity (N = 28)				
Predictor Variables	R^2	β	*t* for parameter	Probability for *t* value
Self-efficacy	.11			
Goal-setting		-0.03	-0.06	.96
Planning		-0.24	-0.39	.70
Physical activity		0.32	1.37	.18
Barrier		0.03	0.12	.91

13-week self-efficacy predicting 6-month volume of physical activity (N = 23)				
Predictor Variables	R^2	β	*t* for parameter	Probability for *t* value
Self-efficacy	.05			
Goal-setting		0.15	0.42	.68
Planning		-0.01	-0.03	.98
Physical activity		-0.26	-0.74	.47
Barrier		-0.03	-0.08	.94

Prediction of 13-week and 6-month volume of physical activity by 6- and 13-week outcome expectations. Correlations between 6- and 13-week outcome expectations and 13-week and 6-month volume of physical activity can be found in Table 14. To determine if social, physical and psychological outcome expectations at 6-weeks would predict volume of physical activity at 13-weeks, a linear regression analysis was conducted. All three subscales of 6-week outcome expectations were entered in as one step in the model to predict 13-week volume of physical activity. The overall model for 6-week outcome expectations predicting 13-week volume of physical activity was not significant R^2 = .15 (R^2_{adj} = .01), $F(3, 17)$ = 1.02, p = .41 (see Table 15).

To determine if social, physical and psychological outcome expectations at 13-weeks would predict volume of physical activity at 6-months, a linear regression analysis was conducted. All three subscales of 13-week outcome expectations were entered in as one step in the model to predict 6-month volume of physical activity. The overall model for 13-week outcome expectations predicting 6-month volume of physical activity was not significant R^2 = .19 (R^2_{adj} = .05), $F(3, 18)$ = 1.39, p = .28 (see Table 15). Although the model was not significant, the beta values associated with physical and psychological outcome expectations deserve attention. Specifically, lower physical outcome expectations (β = -.55, p = .13), and higher psychological outcome expectations (β = .56, p = .13) contributed most to this model of prediction of volume of physical activity. These findings suggest that while outcome expectations did not predict short-term (13-weeks) physical activity, there could be a relationship between outcome expectations post-intervention and long-term (6-months) physical activity.

Table 14

Means, Standard Deviations and Correlations between Outcome Expectations and Volume of Physical Activity

	M	*SD*	1	2	3	4
6-week outcome expectations predicting 13-week volume of physical activity						
1. Volume	435.71	305.48	-	.20	-.33	-.31
2. Social	7.42	1.29		-	-.03	.07
3. Physical	7.88	1.03			-	.84***
4. Psychological	7.58	1.06				-
13-week outcome expectations predicting 6-month volume of physical activity						
1. Volume	364.09	198.52	-	.07	.01	.28
2. Social	6.16	2.38		-	.26	.24
3. Physical	8.00	1.30			-	.79***
4. Psychological	7.52	1.53				-

Note. Volume = volume of physical activity per week (minutes/week). Self-efficacy was measured on a 0 (*Absolutely not confident*) to 100 percent (*Absolutely confident*) scale. Outcome expectations were measured on a 1 (*very unlikely*) to 9 (*very likely*) scale. Satisfaction was measured on a -4 (*very unsatisfied*) to 4 (*very satisfied*) scale. Enjoyment was measured on a 1 (*I hate it*) to 7 (*I enjoy it*) scale.

* $p < .05$; **$p < .01$; ***$p < .001$.

Table 15

Multiple Regression Analysis for Outcome Expectations to Predict Volume of Physical Activity

6-week outcome expectations predicting 13-week volume of physical activity (N = 21)				
Predictor Variables	R^2	β	t for parameter	Probability for t value
Outcome expectations	.15			
Social		0.20	0.90	.38
Physical		-0.16	-0.38	.71
Psychological		-0.19	-0.47	.65

13-week outcome expectations predicting 6-month volume of physical activity (N = 22)				
Predictor Variables	R^2	β	t for parameter	Probability for t value
Outcome expectations	.19			
Social		0.05	0.23	.82
Physical		-0.55	-1.58	.13
Psychological		0.56	1.61	.13

Prediction of 13-week and 6-month volume of physical activity by 6- and 13-week enjoyment. Correlations between 6- and 13-week enjoyment and 13-week and 6-month volume of physical activity can be found in Table 16. To determine if enjoyment at 6-weeks would predict volume of physical activity at 13-weeks, a linear regression analysis was conducted. Enjoyment at 6-weeks was entered in the model to predict 13-week volume of physical activity. The overall model for 6-week enjoyment predicting 13-week volume of physical activity was not significant $R^2 = .01$ ($R^2_{adj} = -.02$), $F(1, 26) = 0.37$, $p = .55$ (see Table 17).

To determine if enjoyment at 13-weeks would predict volume of physical activity at 6-months, a linear regression analysis was conducted. Enjoyment at 13-weeks was entered in the model to predict 6-month volume of physical activity. The overall model was not significant, $R^2 = .01$ ($R^2_{adj} = -.05$), $F(1, 22) = 0.01$, $p = .98$ (see Table 17). Taken together, these findings suggest that enjoyment does not predict short-term (13-weeks), or long-term (6-months) physical activity.

Table 16

Means, Standard Deviations and Correlations between Enjoyment and Volume of Physical Activity

	M	*SD*	1	2
6-week enjoyment predicting 13-week volume of physical activity				
1. Volume	441.96	298.82	-	-.07
2. Enjoyment	5.60	0.99		-
13-week self-efficacy predicting 6-month weekly energy expenditure				
1. Volume	356.29	213.93	-	.01
2. Enjoyment	5.62	1.16		-

Note. Volume = volume of physical activity per week (minutes/week). Self-efficacy was measured on a 0 (*Absolutely not confident*) to 100 percent (*Absolutely confident*) scale. Outcome expectations were measured on a 1 (*very unlikely*) to 9 (*very likely*) scale. Satisfaction was measured on a -4 (*very unsatisfied*) to 4 (*very satisfied*) scale. Enjoyment was measured on a 1 (*I hate it*) to 7 (*I enjoy it*) scale.

* $p < .05$; **$p < .01$; ***$p < .001$.

Table 17

Linear Regression Analysis for Enjoyment to Predict Volume of Physical Activity

6-week enjoyment predicting 13-week volume of physical activity (N = 28)				
Predictor Variables	R^2	β	t for parameter	Probability for t value
Enjoyment	.01	-0.12	-0.61	.55
13-week enjoyment predicting 6-month volume of physical activity (N = 24)				
Predictor Variable	R^2	β	t for parameter	Probability for t value
Enjoyment	.01	0.01	0.03	.98

Prediction of 13-week and 6-month volume of physical activity by 6- and 13-week satisfaction. Correlations between 6- and 13-week satisfaction and 13-week and 6-month volume of physical activity can be found in Table 18. To determine if satisfaction with outcomes, current state, and outcomes from the REACH program at 6-weeks would predict volume of physical activity at 13-weeks, a linear regression analysis was conducted. All three subscales of 6-week satisfaction were entered in as one step in the model to predict 13-week volume of physical activity. The overall model for 6-week satisfaction predicting 13-week volume of physical activity was not significant R^2 = .08 (R^2_{adj} = -.04), F(4, 24) = 0.67, p = .58 (see Table 19).

To determine if satisfaction with outcomes, current state and outcomes from the REACH program at 13-weeks would predict volume of physical activity at 6-months, a linear regression analysis was conducted. All three subscales of 13-week satisfaction were entered in as one step in the model to predict 6-month volume of physical activity. The overall model did not reach standard levels of significance, $R^2 = .29$ ($R^2_{adj} = .18$), $F(3, 20) = 2.65$, $p = .08$ (see Table 19). Although the model was not significant, the beta values associated with satisfaction with current state and with outcomes from the REACH program deserve attention. Specifically, lower satisfaction with the participant's physical current state ($\beta = -0.48$, $p = .20$) and higher satisfaction with weight loss outcomes ($\beta = 0.59$, $p = .12$) contributed most to this model of prediction of volume of physical activity. Taken together, these findings suggest that satisfaction does not appear to influence short-term physical activity (13-weeks), however there may be a weak relationship between satisfaction post-intervention and long-term (6-months) physical activity.

Table 18

Means, Standard Deviations and Correlations between Satisfaction and Volume of Physical Activity

	M	*SD*	1	2	3	4
6-week satisfaction predicting 13-week volume of physical activity						
1. Volume	441.96	298.82	-	-.07	-.21	-.19
2. S – outcomes	2.50	1.04		-	.80***	.79***
3. S – current state	2.60	1.19			-	.84***
4. S – REACH	2.47	1.38				-
13-week self-efficacy predicting 6-month volume of physical activity						
1. Volume	365.67	217.62	-	.01	-.25	.28
2. S – outcomes	2.39	1.03		-	.81***	.82***
3. S – current state	2.44	1.37			-	.51**
4. S – REACH	2.33	1.40				-

Note. S = Satisfaction; volume = volume of physical activity per week (minutes/week). Self-efficacy was measured on a 0 (*Absolutely not confident*) to 100 percent (*Absolutely confident*) scale. Outcome expectations were measured on a 1 (*very unlikely*) to 9 (*very likely*) scale. Satisfaction was measured on a -4 (*very unsatisfied*) to 4 (*very satisfied*) scale. Enjoyment was measured on a 1 (*I hate it*) to 7 (*I enjoy it*) scale.

* $p < .05$; **$p < .01$; ***$p < .001$.

Table 19

Multiple Regression Analysis for Satisfaction to Predict Volume of Physical Activity

6-week satisfaction predicting 13-week volume of physical activity (*N* = 28)				
Predictor Variables	R^2	β	*t* for parameter	Probability for *t* value
Psychosocial predictors	.08			
S – outcomes		0.33	0.94	.36
S – current state		-0.32	-0.78	.44
S – REACH program		-0.18	-0.47	.64
13-week satisfaction predicting 6-month volume of physical activity (*N* = 24)				
Predictor Variables	R^2	β	*t* for parameter	Probability for *t* value
Psychosocial predictors	.29			
S – outcomes		-0.08	-0.15	.88
S – current state		-0.48	-1.31	.20
S – REACH program		0.59	1.61	.12

Note. S = Satisfaction.

Satisfaction and Enjoyment as Mediators of Volume of Physical Activity

Residual change in satisfaction and enjoyment between baseline and 13-weeks were hypothesized to mediate the relationship between exercise condition and volume of physical activity at 6-months. Barron and Kenny's (1986) procedures for mediational analyses were followed to test hypothesis eight. Specifically, their four-step process of testing for mediation, as follows, was used. First, the predictor variable (i.e., exercise condition) must be significantly related to the mediator (i.e., satisfaction or enjoyment). The solid line labeled path A in Figure 26 illustrates this relationship. Second, the mediator (i.e., satisfaction or enjoyment) must be significantly related to the outcome variable (i.e., volume of physical activity), as shown by the solid line labeled path B in Figure 26. Third, the predictor variable (i.e., exercise condition) must be significantly related to the outcome variable (i.e., volume of physical activity), as shown by the solid line labeled path C in Figure 26. Fourth, when the mediator is controlled for, the effect of the predictor variable (i.e., exercise condition) on the outcome variable (i.e., volume of physical activity) is eliminated (full mediation) or is reduced (partial mediation), as shown by the dotted line labeled path D in Figure 26.

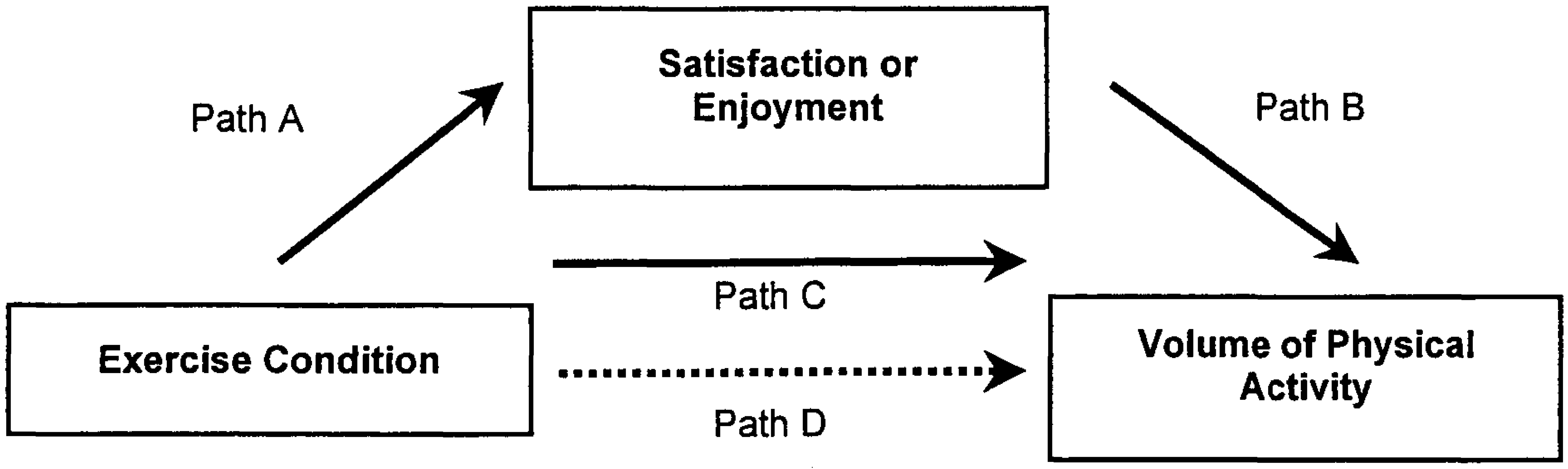

Figure 26. Path diagram of satisfaction or enjoyment as a potential mediator of volume of physical activity.

Residual change in outcome satisfaction as a potential mediator of physical activity at 6-months. Residual change in satisfaction was calculated by curve estimation, entering baseline outcome satisfaction as the independent variable and 13-week outcome satisfaction as the dependent variable. Exercise condition did not significantly predict residual change in outcome satisfaction, $R\Delta^2 < .01$, $F\Delta\ (1,28) = 0.21$, $p = .65$ ($\beta = .09$, $p = .65$, see Figure 27). Because the first condition of mediation (path A) was not met, subsequent testing of pathways B, C, and D was not performed.

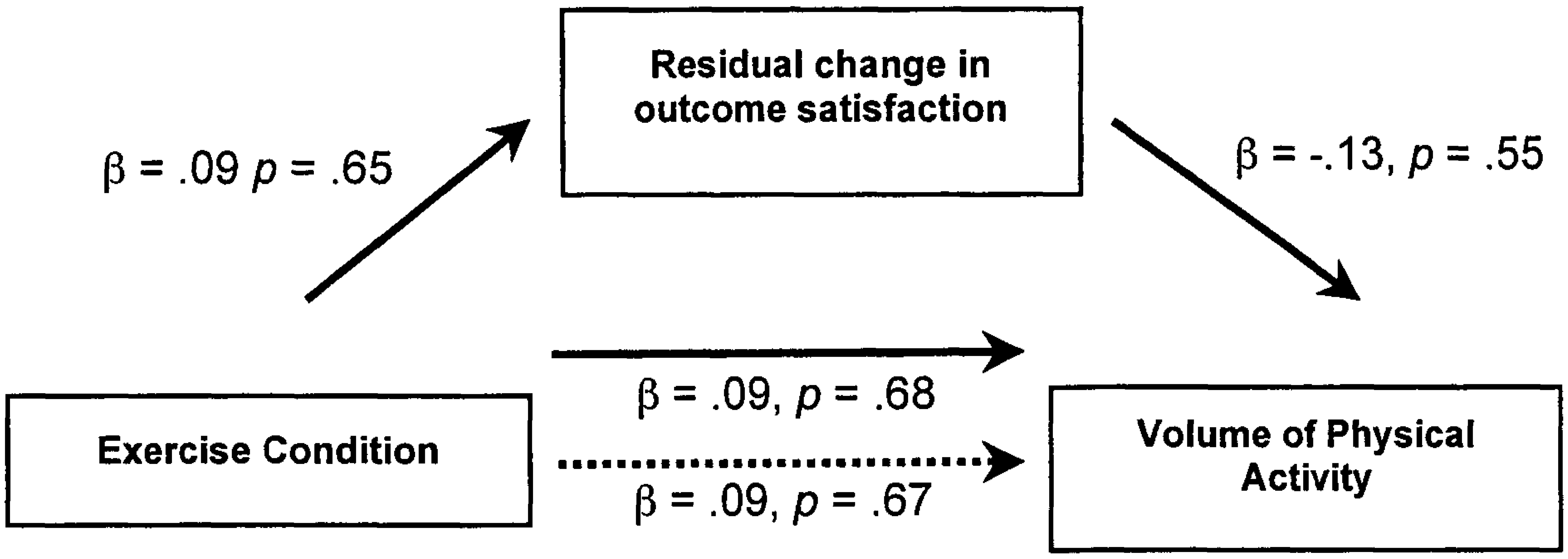

Figure 27. Path diagram of residual change in outcome satisfaction as a potential mediator of 6-month volume of physical activity.

Residual change in current state satisfaction as a potential mediator of physical activity at 6-months. Similar to outcome satisfaction, exercise condition did not significantly predict residual change in current state satisfaction, $R\Delta^2 = .07$, $F\Delta\ (1,23) = 1.74$, $p = .20$ ($\beta = -.27$, $p = .20$, see Figure 28). Because the first condition of mediation (path A) was not met, subsequent testing of pathways B, C, and D was not performed.

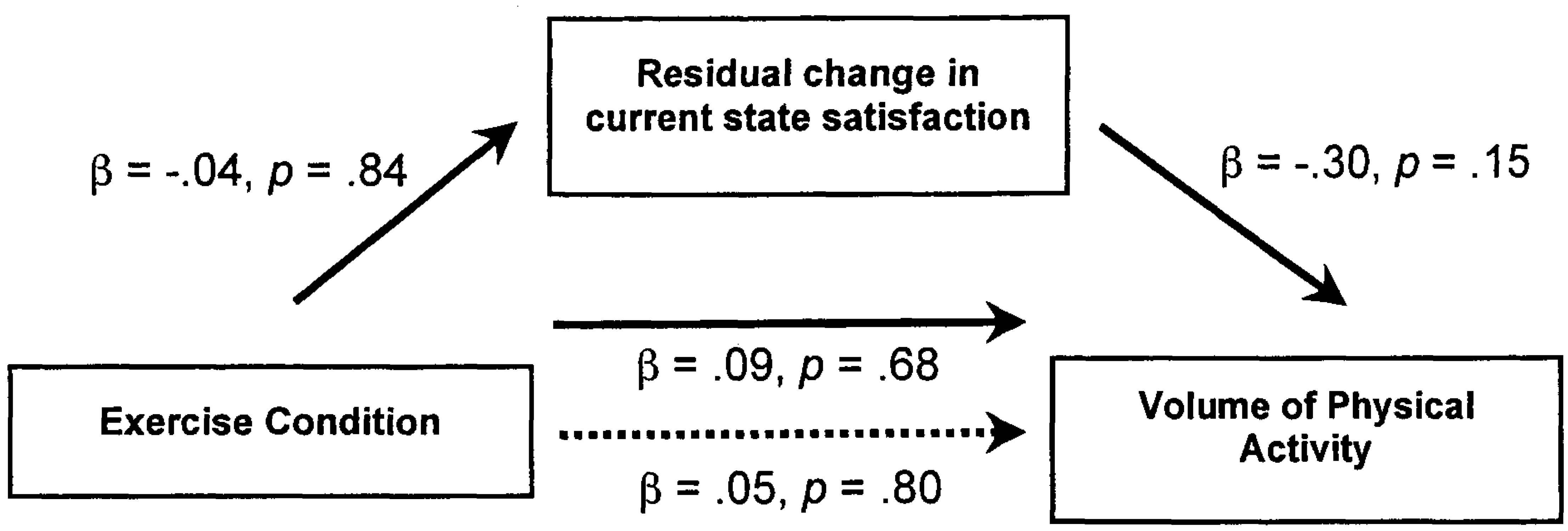

Figure 28. Path diagram of residual change in current state satisfaction as a potential mediator of 6-month volume of physical activity.

Residual change in REACH program satisfaction as a potential mediator of physical activity at 6-months. Exercise condition did not significantly predict residual change in satisfaction with outcomes from REACH, $R\Delta^2 < .05$, $F\Delta$ (1,27) = 0.32, $p = .57$ ($\beta = .11$, $p = .32$, see Figure 29). Because the first condition of mediation (path A) was not met, subsequent testing of pathways B, C, and D was not performed.

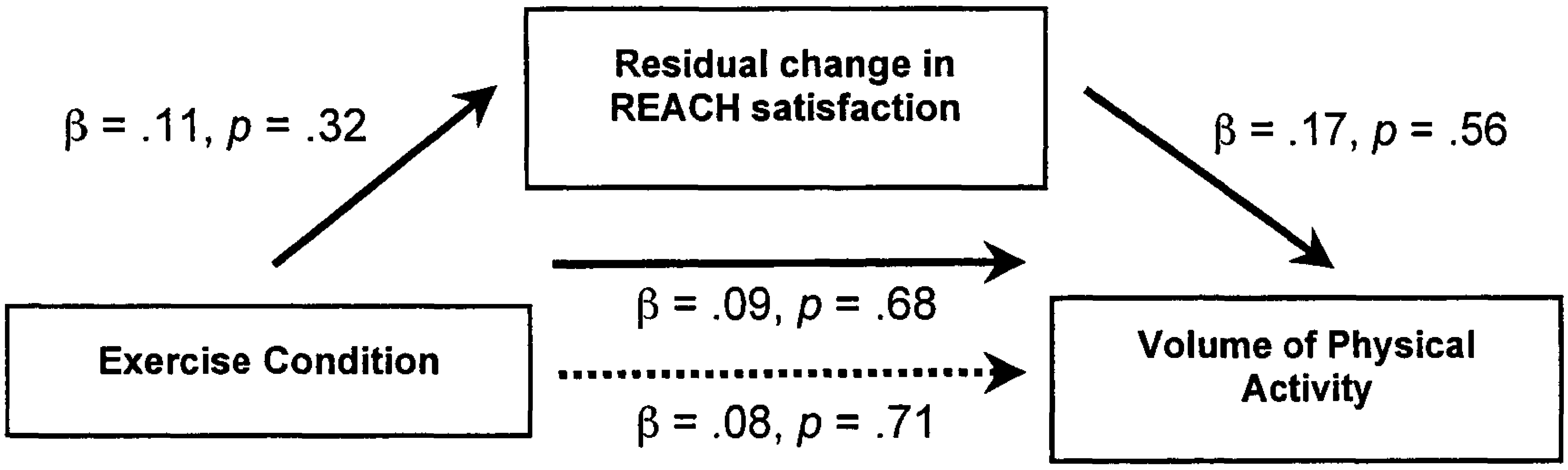

Figure 29. Path diagram of residual change in satisfaction with outcomes from REACH as a potential mediator of 6-month volume of physical activity.

Residual change in enjoyment as a potential mediator of physical activity at 6-months. Exercise condition did not significantly predict residual change in enjoyment, $R\Delta^2 < .05$, $F\Delta$ (1,27) = 0.38, $p = .54$ ($\beta = .12$, $p = .54$, see Figure 30). Because the first condition of mediation (path A) was not met, subsequent testing of pathways B, C, and D was not performed.

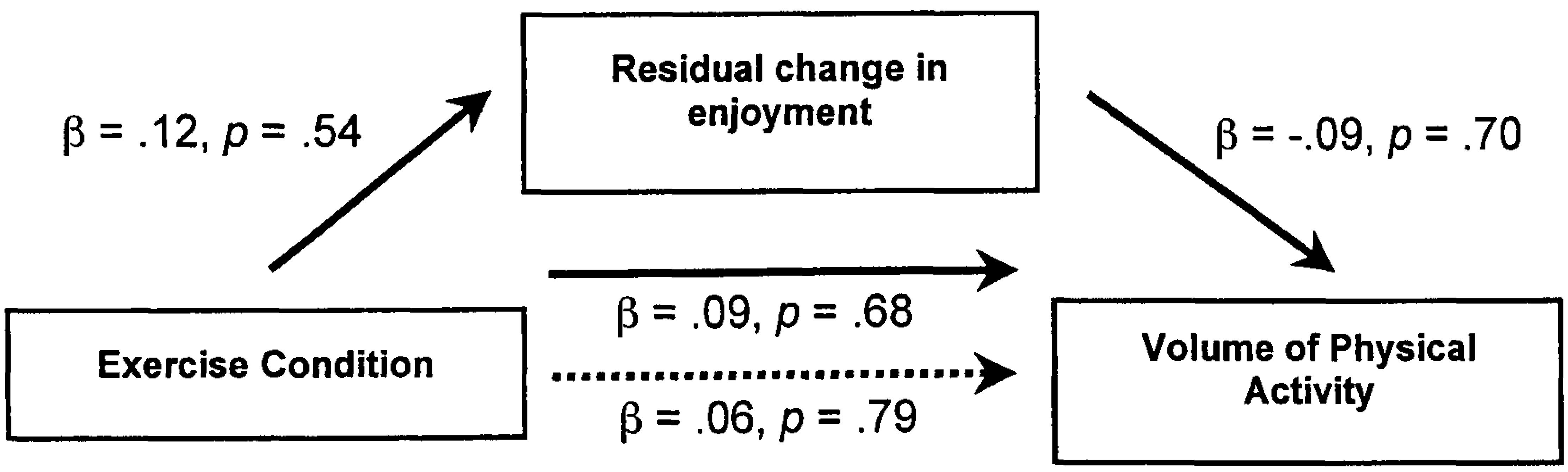

Figure 30. Path diagram of residual change in enjoyment as a potential mediator of volume of physical activity at 6-months.

Chapter 3: Conclusion

Discussion

The main goal of this study was to examine the effects of a moderate and vigorous intensity exercise plus GMCB intervention on obese adolescents' independent physical activity, social cognitions, body composition and fitness. Results from this study indicate that the intervention was successful in teaching obese adolescents to engage in regular, independent physical activity after intervention completion, regardless of level of exercise intensity in which participants engaged. Social cognitions and fitness improved or were maintained over the course of the intervention and also were not differentially affected by exercise intensity. Potential explanations for the study findings and implications are discussed below.

Effects of the Intervention on 13-week and 6-Month Physical Activity

To date, interventions aimed to get obese youth more physically active have been plagued with methodological limitations (Van Sluijs, McMinn, & Griffin, 2007). Findings from the present study represent advancement in theory-based physical activity interventions for obese youth. Specifically, our finding that at both 13-week and 6-month follow-ups participants engaged in a greater frequency and volume of physical activity per week as compared to baseline, provide preliminary evidence that a combined exercise plus GMCB intervention can be an effective treatment option to facilitate long-term independent physical activity in obese youth. These findings are in line with previous GMCB interventions. For example, the first published GMCB intervention found that at 9-

months follow-up, elderly adults who had been in a combined GMCB plus physical activity condition engaged in a higher frequency of weekly physical activity per week as compared to participants who had been in a standard physical activity program (Brawley et al., 2000). Similar findings were found for cardiac patients (Rejeski et al., 2003) and post-natal women (Cramp & Brawley, 2006), such that participants in the GMCB plus physical activity condition engaged in significantly more independent physical activity at follow-ups as compared to those in the standard exercise program. Examination of the social cognitions assessed in this study can offer potential reasons as to why this intervention was successful in helping obese adolescents engage in more independent physical activity after intervention completion.

Effects of the Intervention on Social Cognitions

For almost all social cognitions examined in this study a similar pattern emerged, such that immediately following the 12-week GMCB plus exercise intervention, participants in both moderate and vigorous exercise conditions reported higher physical activity and barrier efficacy, enjoyment of physical activity, and satisfaction with weight related outcomes and their current physical state. Mean values for goal setting and planning efficacy, outcome expectations, and satisfaction with outcomes from the REACH program were successfully maintained for participants in both conditions over the 12-week intervention.

Self-efficacy. Bandura considers mastery experiences the most potent source of self-efficacy (Bandura, 1982). Participants in both conditions had the opportunity to master physical activity through engaging in physical activity regularly in the REACH intervention. In line with social cognitive theory (Bandura, 1986), participants consequently reported increases in their confidence to engage in light, moderate and vigorous intensity physical activity over the course of the intervention.

Interestingly, there were no significant differences between the exercise conditions in self-efficacy for vigorous physical activity, despite participants in the vigorous condition acquiring considerably more mastery experiences with this level of exercise intensity as compared to those in the moderate condition. Several possible reasons could explain this null finding. First, all participants were encouraged to engage in physical activity outside of REACH that was of at least a moderate intensity. As such, participants in both conditions may have engaged in physical activity at a lower or higher intensity than what they were assigned to in REACH exercise sessions. It is plausible, for instance, that participants in the moderate condition were gaining mastery experiences with vigorous activity outside of REACH, and thus experienced equivalent increases in self-efficacy for vigorous exercise as those in the vigorous condition. Second, the GMCB sessions were designed to specifically help obese adolescents become more confident to engage in regular physical activity (Brawley et al., 2000). Because both conditions received the exact same GMCB intervention, in hindsight it may have been unrealistic to expect group differences for physical activity self-efficacy. Recently, physical activity self-efficacy was demonstrated to be a predictor of children's independent physical activity (Foley et al., 2008). From a childhood obesity treatment standpoint, it is encouraging that after only

12-weeks of structured exercise, all participants in the present study were significantly more confident to engage in light, moderate and vigorous intensity physical activity.

As expected, barrier self-efficacy increased over time in both conditions. These findings demonstrate the success of the GMCB intervention, which was designed to specifically help obese adolescents develop the skills to overcome barriers to physical activity (Brawley et al., 2000). Over the course of the intervention, participants in both conditions frequently had the opportunity to practice overcoming barriers to physical activity, serving as mastery experiences. As demonstrated by Foley et al. (2008), barrier self-efficacy has been shown to predict children's independent physical activity. Again, these findings should be encouraging for the treatment of childhood obesity, as they suggest that the GMCB format and intervention materials may be an effective way to help obese youth become more confident in overcoming barriers to physical activity, which could ultimately contribute to greater participation in physical activity.

Surprisingly, there were no improvements in self-efficacy for either goal setting or planning post-intervention. The structured exercise intervention format may have minimized the necessity for planning, and thus could have contributed to the lack of improvements in planning self-efficacy. However, given that participants were weaned off of the structured exercise sessions beginning at week 7, and were encouraged to set goals with respect to participating in independent physical activity throughout the intervention, other factors may be contributing to this null effect.

Upon reflection, when confidence to engage in effective goal setting and planning was assessed at week 2, participants were already reasonably confident to engage in these behaviours. As a consequence, a ceiling effect may have occurred such that there was little room for statistical improvement in goal setting or planning self-efficacy from baseline scores ($M_{goal\ setting}$ = 69.35, $M_{planning}$ = 71.00). Furthermore, it could be the case that these levels of confidence to engage in planning and goal setting may be as high as they can be for the developmental level of this population.

Given that previous GMCB interventions have only been tested in adults, another possible reason that we did not find increases in these forms of self-efficacy is because the GMCB material may not have been salient for obese adolescents with respect to confidence to engage in goal setting and planning. As an example, some participants commented that they did not utilize the physical activity planning sheets (see Appendix D) provided in the GMCB sessions, but rather preferred to "make their physical activity plans in their head." Young adolescents may not need to have confidence in their ability to plan physical activity behaviour as much as adults do, who must balance exercise along with work, social, family, and household demands.

Absence of a control condition in the present study further limits the ability to detect group differences in any of the modes of self-efficacy assessed. Based on past GMCB intervention results where a control condition was utilized (i.e., a group that did not participate in GMCB sessions; Cramp & Brawley, [2006]; Rejeski et al., [2003]), it seems probable that group differences in self-efficacy would have occurred had we compared participants receiving the self-efficacy boosting GMCB material to participants receiving only attention-control materials.

Outcome expectations. Neither the GMCB intervention, nor exercise intensity influenced social, physical or psychological outcome expectations. These findings are consistent with Cramp and Brawley's (2006) GMCB intervention for post-natal women, such that outcome expectations were maintained over the course of the intervention. Maintenance of outcome expectations in the present study is promising, as participants reported relatively high outcome expectations at the beginning of this study. Specifically, these findings could be interpreted to mean that the intervention was successful at helping participants feel they were achieving the social, physical and psychological outcomes they hoped to experience through participation in this study and thus continued to expect that such outcomes would continue to be achieved. In line with social cognitive theory (Bandura, 1986) and as Rothman (2000) suggests, if people achieve the outcomes they expected to when they sought 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 affect decisions to continue behaviours, and ultimately influence long-term healthy lifestyle choices.

The present study is the first that we are aware of to specifically target outcome expectations in an intervention for the treatment of adolescent obesity. These novel findings suggest that the intensity of an exercise program does not necessarily influence the maintenance of high outcome expectations. In other words, participants do not have to work at a vigorous intensity to feel as though they are achieving the outcomes they desired to attain from an adolescent obesity treatment program. Finally, the maintenance of high outcome expectations may have contributed to the excellent adherence rates to the 12-week exercise program in this study. Because participants felt they were achieving the outcomes they hoped to achieve, they may have been highly motivated to continue with the program.

Enjoyment. Contrary to previous research (Ekkekakis, Hall, & Petruzzello, 2008), exercise intensity did not affect enjoyment of physical activity. However, because all participants reported enjoying physical activity *more* over the course of the intervention, these findings should be viewed positively. These findings suggest that the intervention positively influenced obese children's perception of physical activity regardless of exercise condition. Even when obese adolescents were pushed to exercise at a vigorous intensity, they still reported enjoying physical activity just as much as obese adolescents engaging in physical activity at a moderate intensity.

Consideration of participants' high self-efficacy offers a potential rationale for these findings. Previous studies have established a strong link between self-efficacy and exercise enjoyment (Hu, Motl, McAuley, & Konopack, 2007). For example, in a study attempting to manipulate self-efficacy, low to moderately active women engaged in a maximal exercise test and were either told they performed in the top 20^{th} percentile (high efficacy condition) or bottom 20^{th} percentile (low efficacy condition) for their age and gender (Hu et al., 2007).

Individuals in the high efficacy condition reported enjoying exercise significantly more than those in the low efficacy condition. In accordance with Hu and colleagues' findings, participants in both exercise conditions in the present study reported similar high self-efficacy scores for vigorous intensity exercise, and no differences between exercise conditions on exercise enjoyment. The potential moderating role of physical activity self-efficacy on exercise enjoyment may be an avenue worthy of future research.

Satisfaction. Similar to the other social cognitions, there were no significant differences between exercise conditions for any of the satisfaction subscales. However, there were significant increases in satisfaction with outcomes and current physical state for all participants, regardless of exercise condition. Of note, satisfaction with changes resulting from the REACH program did not change significantly over time. These findings are not consistent with previous work examining the role of these three types of satisfaction in a weight loss study with adults (Jeffery et al., 2006). Over the course of the weight loss intervention designed by Jeffery and colleagues, participants were significantly *less* satisfied with their progress and reported no changes in current state satisfaction. However Jeffery et al. did find similar results to the current study such that no differences in satisfaction with changes from the program were found over time.

In another study by the same group of researchers utilizing a slightly different method to manipulate satisfaction, satisfaction was correlated with weight loss, such that participants who lost more weight were more satisfied

(Finch et al., 2005). However, neither of these studies measured behaviours related to weight loss (e.g., nutrition or physical activity), thus these studies were not able to examine the role of satisfaction in relation to mediating behaviours. In order to effectively target health behaviours, it is essential to measure variables that mediate the behaviour change process, and not simply measure outcomes (Baranowski et al., 1997).

Residual Change in Satisfaction and Enjoyment as Mediators of 6-Month Physical Activity

Residual change in enjoyment and satisfaction did not mediate the relationship between exercise intensity and 6-month physical activity. As outlined by Baranowski et al. (1997), theory-based health behaviour change interventions should aim to identify variables that mediate the behaviour change process. In order to do so, links need to be made between the intervention and the potential mediator, and the potential mediator and the outcome variable. In this study, exercise condition was not related to changes in satisfaction or enjoyment. As previously suggested, it is possible that the exercise conditions in this study were not distinct enough to produce group differences in satisfaction and enjoyment. Satisfaction did, however, emerge as a significant predictor of 6-month physical activity independent of exercise condition. A similar exercise plus GMCB intervention compared to an attention control plus exercise group may be more likely to find significant differences between conditions, thus potentially elucidating the mediating role of satisfaction and other social cognitions.

Effects of Exercise Intensity on Body Composition and Fitness

This exercise plus GMCB intervention was also successful in improving obese adolescents' body composition and fitness, regardless of exercise condition. While we are confident that participants did indeed engage in different intensities of exercise during the structured laboratory exercise sessions based on the manipulation checks, it is possible that the intensities were not distinct enough to produce differing results in body composition and fitness. This null finding may have some very important implications. Specifically, participants in the moderate condition had equal improvements in body composition and fitness as those in the vigorous condition, suggesting that obese youth do not have to work at a vigorous intensity to accrue health and fitness benefits. In other words, for obese adolescents, moderate intensity physical activity may be sufficient enough to achieve weight loss and fitness gains. Indeed, the null findings in the current study are consistent with a previous study examining the effect of moderate and vigorous intensity exercise on obese adolescents' body composition and fitness (Gutin et al., 2005).

Although we were able to ensure that participants engaged in their respective moderate or vigorous intensity exercise programs during REACH, we were unable to control the activity participants completed outside of REACH. Through the GMCB sessions, all participants were encouraged to work towards achieving the goal of engaging in *at least* 30 minutes of moderate to vigorous intensity physical activity on 5 or more days of the week. As evidenced by the physical activity data at 13-weeks, participants in both conditions were engaging in similar weekly energy expenditure, frequency, duration and volume of physical activity. It is not surprising that similar improvements were found in participants' body composition and fitness, irrespective of exercise condition.

Prediction of 13-Week and 6-Month Physical Activity

Independent of exercise condition, the 6- and 13-week self-efficacy models did not correlate with or predict 13-week or 6-month volume of physical activity. Specifically, physical activity, barrier, planning and goal setting self-efficacy were not correlated with or predictive of 13-week or 6-month physical activity. These findings are in contrast to a recent study by Foley and colleagues (2008), which found that task (i.e., physical activity) and barrier efficacy were the strongest predictors of children's self-reported physical activity. In interpreting this discrepancy it is important to note the considerable differences between the present study and the study conducted by Foley and colleagues. Whereas the present study attempted to target self-efficacy in an intensive 12-week intervention, Foley and colleagues assessed current state self-efficacy without intervening. Another important difference to note with regard to study findings is that Foley and colleagues used children's current state self-efficacy scores to predict physical activity one week later. In the present study, self-efficacy was used to predict physical activity 6 weeks and 3 months later. It is possible that self-efficacy is a stronger predictor of children's physical activity in the short-term, and other social cognitions are implicated when predicting long-term physical activity.

Similar to self-efficacy, independent of exercise condition, the 6- and 13-week outcome expectations models did not correlate with or predict 13-week or 6-month volume of physical activity. These null findings actually replicate much of the other research on outcome expectations and physical activity (Anderson et al., 2007; Lewis, Marcus, Pate, & Dunn, 2002; Prodaniuk, Plotnikoff, Spence, & Wilson, 2004), which have also found that outcome expectations fail to predict physical activity. Social cognitive theory presumes that in order for people to engage in a behaviour, they need to believe that positive outcomes will result from such behaviour (Bandura, 1986). In the present study, the lack of predictive ability of outcome expectations could be a statistical issue, such that low variability in outcome expectations at 6- and 13-weeks may contribute to the null finding of predicting physical activity. As with other statistical analyses in the present study, limited sample size may have also contributed to our inability to detect outcome expectations as a significant predictor of long-term physical activity. Although the prediction model was not significant, it should be acknowledged that 19% of the variance in 6-month physical activity was accounted for by outcome expectations.

Similar to self-efficacy and outcome expectations, enjoyment of physical activity was not correlated with or predictive of 13-week or 6-month physical activity. This finding is in line with social cognitive theory (Bandura, 1986) and Rothman's model of exercise adherence (Rothman, 2000), such that exercise enjoyment may be more important at the beginning of the program, however enjoyment does not account for keeping participants in the program or doing independent physical activity. Because participants reported enjoying physical activity equally in both exercise conditions, it suggests that it may be important for future physical activity interventions for obese adolescents to set a minimum intensity participants should exercise at, and allow them to push themselves to a higher intensity if they desire. Evidence for this exercise prescription recommendation is further supported by our findings that there were no significant differences between exercise conditions in improvements in body composition or fitness.

Although 6- and 13-week satisfaction did not significantly predict 13-week and 6-month physical activity, respectively, greater satisfaction with weight loss outcomes from the REACH program and less satisfaction with current physical state at 13-weeks may have had a predictive relationship with physical activity at 6-months if adequate power had been attained. The beta weights associated with current state satisfaction and satisfaction with outcomes from the REACH program were -.48 and .59 respectively, indicating that for every standardized unit decrease in current state satisfaction and standardized unit increase in satisfaction with outcomes from the REACH program, there was a standardized unit increase in volume of 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 program (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. In this study, individuals who were less satisfied with their current state (cognition), were in an environment that facilitated an active lifestyle (i.e., had YMCA membership and/or joined sports team), and had felt satisfied with the results their previous physical activity efforts had achieved (cognition), may have chosen to continue to do more physical activity (behaviour).

Strengths and Limitations

There are several strengths of this study that should be discussed. This intervention was theoretically driven, using aspects of social cognitive theory (Bandura, 1986) and group dynamics (Carron et al., 1996; Cartwright, 1951; Cartwright & Zander, 1953) that have been associated with exercise adherence (Burke et al., 2005; Carron et al., 1996; Spink & Carron, 1993). Basing this intervention on theory provided a logical framework for the intervention. Mastery experiences for self-regulatory skills and exercise skills known to influence physical activity were targeted for learning and change. Social-cognitions known to be psychological markers of confidence in these skills and amenable to change were assessed at critical time points consistent with planned progress for their development during the intensive phase of the intervention. Furthermore, using theory as a guide for this intervention enabled the examination of potential mechanisms through which the intervention may have worked.

Participants were randomly assigned to the exercise conditions, which eliminated systematic differences between the treatment groups, and allowed for inference of any differences found between conditions to be attributable to the effects of the exercise conditions. Previous childhood obesity treatment studies have generally not discussed blinding of outcome assessors or concealment of treatment, which are essential in preventing biases in the data. Ensuring that assessors were blinded to participant condition for all baseline assessments prevented any bias in collecting baseline assessments. In addition, in this study participants were concealed from which exercise condition they were in to avoid any biased effects on social cognitions. Another strength of the study was the 6-month assessment of physical activity, as this allowed for the examination of independent physical activity maintenance effects (i.e., end of intensive intervention to end of 6 month period) of this GMCB plus exercise intervention.

The use of intervention manipulation checks to examine the social context of the intervention was another important strength of the study as this allowed us to ensure that the specific social environment we aimed to create (i.e., cohesive and collaborative) was successfully attained. Confirmation that conditions were equivalent in group cohesiveness and collaboration was imperative given past research which has demonstrated that social context of interventions plays an important role in the process of behaviour change (Brawley, Rejeski, Angove, & Fox, 2003).

Relative to confirming other aspects of the treatments, there has been controversy in the literature regarding the effects of moderate and vigorous intensity exercise for obese adolescents. The present study ensured participants engaged in the appropriate exercise intensity relative to their assigned condition during the structured laboratory exercise sessions. The supervision of all exercise sessions, objective assessments of heart rate and subjective ratings of perceived exertion all provide evidence that, in each condition, the participants did indeed exercise at their prescribed intensity.

Despite these strengths, several limitations deserve attention. Participants were self-selected and screened for motivation. Interpretation of these results should acknowledge that because participants wished to be a part of such an intensive program, generalizability of this type of intervention may be limited to highly motivated individuals. Assessment of the main outcome variable was through self-report. Although the 7-day PAR has demonstrated acceptable validity and reliability with heart rate data (Sallis et al., 1993), these data were not confirmed with an objective measure of physical activity. It should be noted that attempts were made to collect an objective measure of physical activity in this study. Unfortunately, participant compliance to properly wearing an Actical™ accelerometer (Mini-Mitter) was poor and thus objectively assessed physical activity data were deemed unreliable. Reasons why these data were deemed unreliable include: participants not wanting to wear the device for at least 10 hours per day for at least 5 days, participants refusing to wear the device during physical activity because of discomfort, participants indicating they forgot to wear the device, and finally some participants returned the device and said they had not worn it on their right hip as they had been instructed.

The lack of a control group in this study was a considerable limitation, specifically for interpreting the results. Unfortunately, due to this study being part of a larger, multidisciplinary clinical trial, the researcher had minimal control over study design for this aspect of the trial. The inclusion of a control group may have revealed group differences in the outcome variables (specifically social cognitions), further elucidating the effects of the intervention on social cognitions and their potential role as mediators for independent physical activity. It should also be noted that the GMCB session leader was also the exercise leader for the vigorous exercise condition. Although similar GMCB leader and exercise leader collaboration were reported for both exercise conditions, this feature of the study may have impacted several social cognitions. For example, the GMCB leader also being the exercise leader for the vigorous condition may have provided additional social support due to potentially enhanced rapport with the participants.

It should be noted that the wording regarding the time course in the efficacy measures was not consistent. This may partially explain why self-efficacy did not predict physical activity behaviour. Finally, the small sample size resulted in some analyses being underpowered and restricted interpretation of some of the findings. Further, due to limited power, the decision to run multiple ANOVAs and regressions due to limited sample size correspondingly increased the chance of committing a type two error.

Future Directions

A logical future area of study is the comparison of a GMCB plus exercise condition for obese adolescents compared with a control condition, consisting of an attention control plus exercise. Such an intervention could elucidate which social cognitions the GMCB intervention specifically changes, as compared to standard control. Furthermore, in a future GMCB exercise study involving an attention control group, based on these 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.

Although physical activity was significantly higher at 6-months for all participants, failure to find a relationship between randomization to exercise condition and physical activity in the mediation models precluded examination of satisfaction or enjoyment as mediators of this relationship. A future similar study involving an attention control condition may better elucidate potential mediators, as it would increase the likelihood that a relationship would exist between randomization to intervention versus a control and predict physical activity. In addition to social cognitions, other mediators could be explored in the relationship between a GMCB intervention plus exercise and physical activity behaviour. Drawing from social cognitive theory (Bandura, 1986), the environment is also a plausible factor that could influence physical activity behaviour. Specifically, access to exercise facilities or areas to engage in physical activity have been related to obese adolescents' independent physical activity behaviour (Sallis, Prochaska, Judith, & Taylor, 2000). Future studies could examine access to such facilities as a potential mediator in predicting long-term independent physical activity.

From a GMCB perspective, future research with obese adolescents could aim to improve upon the material presented in the GMCB sessions, ensuring that salient topics are discussed and in a fashion that is effective for this population. For example, the use of the "buddy system" with this population did not prove to be an effective method as very few of the participants actually contacted their buddy, and to the researchers' knowledge, very few used their buddy as a physical activity partner. Because participants often did not live close to one another, a more effective method of the buddy system could have been to encourage participants to elicit a physical activity buddy in their home environment. For example, teaming up with a family member or close friend outside of REACH may have proven more effective in helping the participant engage in independent physical activity. Indeed, these types of partnerships were encouraged in later GMCB sessions in this study, however family or friend buddies may have been even more effective if encouraged earlier on in the intervention.

Involving parents in the treatment of childhood obesity has been widely established as an important component of successful interventions (Epstein et al., 1981; Golan et al., 1998). Previous studies have included minimal parental involvement (Warschburger, Fromme, Petermann, Wojtalla, & Oepen, 2001), family-based programs (Epstein et al., 1981) and parent-only programs (Golan et al., 1998); however the optimal amount of parental involvement for achieving the greatest health improvements in obese children has yet to be established. Another fruitful area to explore within future GMCB and exercise studies could involve conditions with parallel parental involvement, interactive parental involvement and attention control. Specifically, a parallel parental involvement condition could have parents and children in separate identical GMCB sessions, an interactive parental involvement condition could involve the parents interacting with their children in GMCB sessions, and these two conditions could be compared with a standard care family-based condition, in which parents and children are only given health information and encouraged to exercise on their own (i.e., not a GMCB format). In addition to providing valuable information to the childhood obesity treatment literature, this type of a study would allow the examination of whether GMCB sessions are more effective if only similar others are included (i.e., only obese children, or only parents of obese children), or if there are additive benefits (i.e., in terms of social cognitions or health benefits) of having both parent and child interacting in the GMCB groups together.

Conclusion

The findings from this study provide preliminary evidence that the GMCB intervention format can be effective for helping obese youth learn to engage in independent physical activity after intervention completion. Moderate or vigorous exercise did not appear to differentially influence social cognitions, short or long-term physical activity adherence, or improvements in body composition or fitness. Taken together, these findings suggest that exercise programs for obese adolescents can be at a moderate intensity and still enable participants to accrue improvements in body composition and fitness, attain improvements in social cognitions related to physical activity, and adhere to physical activity independently. Furthermore, for more motivated participants such as the present sample, exercising at a vigorous intensity should not be discouraged. The present study findings suggest that vigorous exercise was not associated with lower self-efficacy, outcome expectations enjoyment or satisfaction. Although more research needs to examine social cognitive factors impacting obese adolescent's independent physical activity behaviour, this study provides theory-based evidence that GMCB interventions can have favourable effects in this population. Future childhood obesity interventions should capitalize on the findings of the current study regarding satisfaction and help participants feel satisfied with the outcomes their efforts have achieved, which in turn could lead to continuing to engage in healthy behaviours.

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Appendix A

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Office of Research Ethics

The University of Western Ontario
Room 4180 Support Services Building, London, ON, Canada N6A 5C1
Telephone: Fax: Email:
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Western

Use of Human Subjects - Ethics Approval Notice

Principal Investigator: Dr. C.L. Clarson
Review Number: 15590 **Revision Number:** 3
Review Date: July 24, 2009 **Review Level:** Expedited
Protocol Title: Reduction of Adolescent Risk Factors for Type 2 Diabetes and Diabetes-related Cardiovascular Disease
Department and Institution: Paediatrics, London Health Sciences Centre
Sponsor: CIHR-CANADIAN INSTITUTE OF HEALTH RESEARCH
Ethics Approval Date: July 24, 2009 **Expiry Date:** December 31, 2010
Documents Reviewed and Approved: Revised letter of information & consent form dated June 12/09, revised community newspaper ad, revised content for LHSC website version Jun/09, revised poster, revised content for Lawson website version Jun/09 and revised referral form
Documents Received for Information:

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form.

During the course of the research, no deviations from, or changes to, the protocol or consent form may be initiated without prior written approval from the HSREB except when necessary to eliminate immediate hazards to the subject or when the change(s) involve only logistical or administrative aspects of the study (e.g. change of monitor, telephone number). Expedited review of minor change(s) in ongoing studies will be considered. Subjects must receive a copy of the signed information/consent documentation.

Investigators must promptly also report to the HSREB:

a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) all adverse and unexpected experiences or events that are both serious and unexpected;
c) new information that may adversely affect the safety of the subjects or the conduct of the study.

If these changes/adverse events require a change to the information/consent documentation, and/or recruitment advertisement, the newly revised information/consent documentation, and/or advertisement, must be submitted to this office for approval.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

Chair of HSREB: Dr. Joseph Gilbert

Ethics Officer to Contact for Further Information			
Janice Sutherland	☐ Elizabeth Wambolt	☐ Grace Kelly	☐ Denise Grafton

This is an official document. Please retain the original in your files. cc: ORE File LHRI

LAWSON CLINICAL RESEARCH SERVICES

Victoria Hospital
373 Hill Street
Education Building, Room 131
London, Ontario N6A 4G5
Canada

Letter of Information

Title: Reduction of Adolescent Risk Factors for Type 2 Diabetes and Diabetes-related Cardiovascular Disease (REACH)

Sponsor: Children's Hospital, London Health Sciences Centre
Lawson Health Research Institute
University of Western Ontario

Investigators: Dr. Cheril Clarson, Dr. Stewart Harris, Dr. Michelle Jackman, Dr. Farid Mahmud, Dr. Harry Prapavessis, Dr. Kevin Shoemaker, Justine Wilson

The pronouns 'you' and 'your' should be read as referring to the participant rather than the parent or guardian who is signing the consent form for the participant.

Introduction
You are being invited to voluntarily participate in a clinical research study because you are between the ages of 10 and 16 years and may be at risk for developing diabetes or atherosclerosis (hardening of the arteries) in the future. The purpose of this letter is to provide you with the information you require to make an informed decision on participating in this study. Please take your time to read the following information carefully. If you need further information, please ask your study doctor.

Study Purpose
The purpose of this study is to compare changes in lifestyle with diet and exercise alone to changes in lifestyle with diet and exercise in combination with metformin medication. Metformin is a pill that makes the body's insulin work better and when used in combination with improvements in diet and exercise can promote weight loss.

Background
The risk for type 2 diabetes and diabetes related heart disease starts in childhood. Rates of obesity and type 2 diabetes are increasing in children and teenagers and obesity increases the risk for future development of type 2 diabetes and heart disease. It is known that both lifestyle changes and metformin medication can prevent development of diabetes in adults who are at risk for developing diabetes but it is unknown whether these lifestyle changes or medication change the risk for developing diabetes or in children and teenagers. A total of 72 children and teenagers will participate in this study and the study will last for 2 years.

Study Procedure
If you agree to participate in the study there are certain requirements that must be met. The study will be fully explained to you and you will be asked to sign the consent form prior to any study procedures being performed.
You will be seen monthly for the first year and every 3 months during the second year at the Children's Hospital, London Health Sciences Centre (CH, LHSC) at which time blood pressure, height, weight and waist circumference will be measured. Each visit will take about 1 ½ hours. At Screening, 6, 12 and 24 month visits 2 blood samples equal to approximately 2 teaspoons will also be taken and a finger probe test will be done. You will be randomized into a vigorous or

moderate intensity 12-week exercise program and expected to attend 3 weekly exercise sessions lasting for 1 hour. This exercise program will take place at the Exercise and Health Psychology Lab, UWO. If you are randomized to the vigorous exercise program the exercise sessions will be more challenging than for the moderate program. You also will participate in weekly 20 minute group sessions (during the same time you come to exercise) where you will learn skills to help you maintain a healthy active lifestyle. There will be weekly group physical activity sessions for an additional 92 weeks after the 12 week randomized phase. At baseline screening, 6 and 12 weeks and 6, 12 and 24 months you will be asked to complete quality of Life and Psychological questionnaires. At baseline screening, 3, 6, 12 and 24 months physical health will be assessed using DEXA scan, electrocardiogram (ECG), ultrasound and blood pressure measurements, as well as fitness and activity (see Entry visit 2 below)

Girls assigned to metformin must have a urinary pregnancy test prior to study entry and this will be repeated every 6 months during the study. If the pregnancy test is positive, they will be required to withdraw from the study. Girls receiving metformin who are sexually active should use an effective birth control method.

Screening Visit (will take approximately 2 ½ hours)
At the Screening Visit at Children's Hospital, London Health Sciences Centre you will be assessed by a social worker and seen by a pediatric endocrinologist.

Entry Visit 1 (will take approximately 1 hour)
This visit will take place at Children's Hospital, London Health Sciences Centre. During this visit you will have the following procedures performed:

- A fasting blood test when approximately 1-2 teaspoons of blood will be drawn for measurement of insulin, sugar, cholesterol, triglycerides, adipocytokines (fat hormones), liver and kidney function. You will be given a sugar containing drink and two hours later another blood test (less than half a teaspoon of blood) will be taken to repeat the blood sugar measurement.
- Physical examination.
- Vascular assessment (blood pressure, and a finger probe test using thimble-shaped probes on the tips of your fingers to test for early signs of atherosclerosis or hardening of the arteries).
- Dietary assessment using 3-day food record.

Entry Visit 2 (will take approximately 2 hours)
This visit will take place at Exercise and Health Psychology Laboratory, UWO. During this visit you will have the following procedures performed:

- DEXA scan (an x-ray used to assess body composition by measuring the amount of fat and muscle in the body).
- Activity will be assessed using an accelerometer to measure activity-related energy expenditure movement. This is a small device, the size of an iPod worn on the right hip during the waking hours for seven days.
- Fitness will be assessed by measuring how well your lungs and heart react to exercise on a standardized treadmill protocol.
- Quality of Life and Psychological questionnaires will be completed. This will take approximately 30 minutes to complete.
- An ECG, which measures the electrical activity in your heart, will be performed. This is a small device about the size of a cell phone which can be worn on your belt. You will be asked to wear it for 24 hours to record your activity in your heart. After the 24 hours you will be asked to return the system to the study clinic.
- Ultrasound will be performed (obtain images of your heart and different blood vessels).
- Vascular assessment (blood pressure, and a finger probe test using thimble-shaped probes on the tips of your fingers to test for early signs of atherosclerosis or hardening of the arteries).

At completion of Visit 2 procedures, if you meet the eligible criteria you will be randomized (like the flip of a coin) to 1 of 4 groups;

1. Lifestyle intervention with placebo (contains no active medication) and standard study (moderate intensity) exercise program.
2. Lifestyle intervention with metformin and standard study (moderate intensity) exercise program.
3. Lifestyle intervention with placebo (contains no active medication) and a vigorous intensity 12 week exercise program followed by the standard study exercise program.
4. Lifestyle intervention with metformin and a vigorous intensity 12 week exercise program followed by the standard study exercise program.

Lifestyle Intervention

Dietary Intervention

You will be assessed by a dietitian, and be advised on nutrition with emphasis on low fat content and increased fiber. You will be seen monthly by the dietitian for the first 12 months, and every 3 months during the second year. Three day food records will be repeated at 6, 12 and 24 months.

Exercise Intervention - Weeks 1 to 12

The first 12 weeks of the exercise program will be conducted by trained staff in the Exercise and Health Psychology Lab at the University of Western Ontario. As mentioned above, you will be asked to exercise three times per week on a cycle erogometer, rower, treadmill, or stepper, or use age-appropriate resistance training equipment for 12 weeks. Exercise sessions will involve a warm-up, exercise portion and a cool down. You will be in the exercise class for the full hour for every session; however fitness level appropriate exercises will be implemented so that you can gradually maintain longer bouts of exercise. Those in the vigorous exercise group will be expected to work at higher intensity (reflected by their heart-rate) than those in the moderate exercise group.

Weeks 13 to Weeks 104

You will be asked to attend weekly group physical activity sessions at the YMCA of Western Ontario, 382 Waterloo Street, London, Ontario. Each session lasting 1 hour and supervised by a fitness specialist. Activities will include the use of steps, dynabands, fit balls and weights. You will be provided with these devices for daily home use. There is no cost to you; the physical activity sessions will be covered by the study.

Family/Behavioural Intervention

You will be asked to see a social worker once a month for the first year, and every 3 months during the second year to review progress, goals and strategies to achieve goals.

One of your parent's will be asked to come to all study visits and to come to a group meeting lasting for 2 hours once every 3 months. At these meetings the study social worker, dietitian, nurse co-ordinator, fitness specialist or a community health worker will meet with families to discuss any problems with making changes in diet and exercise and explore ways to help you make these changes.

Number of Study Visits

During Week 1 to 12 there will be 41 visits:

- Entry – 2 visits
- Exercise visits - 3 visits per week (total of 36)
- Diet and family/behavioral visits – 1 visit per month (total of 3)

During Week 13 to 52 there will be 53 visits:

- Exercise visits - 1 visit per week (total of 40)
- Diet and family/behavioral visits – 1 visit per month (total of 9)
- Parent group visits (total of 4)

During Week 53 to 104 there will be 60 visits:
- Exercise visits – 1 visit per week (total of 52)
- Diet and family/behavioral visits – 1 visit every 3 months (total of 4)
- Parent group visits - total of 4

Metformin Therapy
If you are assigned to receive metformin you will start therapy at 500mg/day, increasing by 500 mg/day every 7 days to a maximum tolerated dose of 2000mg/day taken before the evening meal as a single dose.

Risks

The most common side effects of metformin are: abdominal pain, diarrhea and nausea and these can be prevented or reduced by gradually increasing the dose over 4 weeks.

The most serious risk is lactic acidosis, which is very rare but if very severe can cause coma. This is extremely rare especially in children and teenagers unless there is a kidney or liver problem. A blood sample to check for kidney and liver function will be done at Screening. If abnormal, you will not be eligible to enter the study. Also if you require an x-ray with contrast material at any time, metformin should be temporarily stopped.

Risk of hypoglycemia (low blood sugar) is very rare in association with metformin, if it occurs it will be treated with oral glucose tablets.

Risks of having DEXA scan: This requires exposure to radiation, but the risk is considered very low. The effective radiation dose from this procedure is about 0.01 mSv, which is about the same as an average person receives from background radiation in 1 day.
these electrodes may cause a small rash which should disappear in a day or two.

Risks of Blood Pressure Measurement: During testing the cuff around your finger may cause your finger to turn slightly blue and feel numb but this goes away quickly when the cuff pressure is reduced. The cuff around your arm will prevent blood from entering your arm for up to 1 minute. There are no risks with stopping blood flow for this duration of time, though the cuff will feel tight around your arm, this sensation goes away immediately upon deflation of the cuff.

Risks of Ultrasound: There are no known risks associated with the use of ultrasound.

Risk of Fitness Assessment: Maximal fitness tests are safe. For clinical tests the estimated risk of a cardiac event is .4 to .5 per 10,000 tests.

Risk of Metformin: It is not known whether or not metformin is safe in pregnant women. In animal studies metformin has not caused any damage to the fetus but animal studies may not predict effects in humans. Therefore, you may not take part in this research study if you are pregnant, breastfeeding or plan to become pregnant while on this study. If you are a woman of childbearing potential, you must discuss birth control measures with your study doctor. To prevent you from becoming pregnant, you will be asked to use medically effective birth control while enrolled in the study such as birth control pills, barrier methods such as a condom or diaphragm, or an intrauterine device (IUD). You must continue using birth control for one month after the end of the study.

If you become pregnant during the study, you will be discontinued from study participation for safety reasons. If you become pregnant within 28 days after you have stopped taking study drug, we ask that you contact your study doctor for safety monitoring. In either case, please make your Obstetrician aware of your study participation. Should you decide to make this information available, your study doctor will ask that you, or your obstetrician, provide updates on the progress of your pregnancy and its outcome.

The finger probe test is radiation free, has no side effects and comfortably rests on the finger tips. It uses a blood pressure cuff which may result in temporary numbness and tingling in the fingers after use.

In addition to the risks listed, there is always the possibility that you may have a side effect that is currently unknown and unanticipated.

Benefits

There is no guarantee that you may benefit directly from this research. Regardless of any individual benefit, the knowledge gained from this study may help other children and teenagers at risk for development of diabetes.

Participation

Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect on your future care.

Withdraw from the study

The study doctor may stop your participation in the study at any time if decided that it is in your best interest or if you are unable to keep appointments. If you are participating in another study at this time, you are not eligible to participate in this study.

Alternatives to participate

If you decide not to participate in the study you will be offered the standard care, a visit with a dietitian every 6 months.

Reimbursement

There is no charge to you for the participation in the study or costs of tests or procedures directly associated with this study. You will receive up to $20 for each study visit/or exercise visit to compensate for travel and any other reasonable out of pocket expenses, that are directly related to your participation in the study. If you do not complete the study, you will not receive the payments you would have received after that point.

Compensation for Injury

If you are injured as a direct result of taking part in this study, medical treatment shall be made available primarily through your study doctor and the London Health Sciences Centre. You have not waived any of your legal rights by signing the consent form.

Confidentiality

All study medical records and research materials in which you are identified will be kept confidential and will not be made publicly available, unless required by applicable laws regulations. If the results of this study are published, no one will know you were a part of the study.

By signing the consent form you allow the review of your study medical records by authorized representatives of Children's Hospital, London Health Sciences Centre, Lawson Health Research Institute, London Health Sciences Centre as well as other doctors, nurses, or personnel involved in the study. Your medical records may be examined in connection with this study or further analyses related to it. If you decide to withdraw from this study, your medical records will be made available as described above.

Representatives of the University of Western Ontario Health Sciences Research Ethics Board may contact you or require access to your study related records to monitor the conduct of the research.

You have the right to look at your study medical records and request correction of any errors about yourself by contacting the study doctor.

We will be informing your primary physician of your participation in the study as part of routine care.

Your study-related records will be kept for a period of 25 years as per the Health Canada Food and Drug Regulations.

Contact for Further Information

Thank you for taking the time to read the information about this study. If you have any questions or concerns now or at any time about the study, your safety or your rights, please ask your study doctor, his study staff or the contact person(s) indicated below.

If you have questions about your rights as a research participant or the conduct of the study you may contact Dr. David Hill, Scientific Director, Lawson Health Research Institute at

If you have any questions during the study, or if you experience any side effects, please contact Dr. Clarson at or the study co-ordinator at

Consent Form

Title: Reduction of Adolescent Risk Factors for Type 2 Diabetes and Diabetes-related Cardiovascular Disease

Sponsor: Children's Hospital, London Health Sciences Centre
Lawson Health Research Institute

Investigators: Dr. Cheril Clarson, Dr Stewart Harris, Dr. Michelle Jackman, Dr Farid Mahmud, Dr. Harry Prapavessis, Dr. Kevin Shoemaker
Justine Wilson MA Candidate

I have read the Letter of Information, have had the nature of the study explained to me and I agree to participate. All questions have been answered to my satisfaction.
I will receive a copy of the Letter of Information and signed Consent Form.

____
Patient's Name/Legally Authorized Representative (Printed)

____ ______________
Patient's Signature/Legally Authorized Representative Date

____
Person Obtaining Consent (Printed)

____ ______________
Person Obtaining Consent (Signature) Date

REACH

Reduction of Adolescent Risk Factors for Type 2 Diabetes and Diabetes-related Cardiovascular Disease

The risk for type 2 diabetes and diabetes-related heart disease starts in childhood. Eating well and getting enough physical activity can decrease the risk for future development of type 2 diabetes and heart disease.

REACH is a clinical research study for youth, age 10-16, designed to compare changes in lifestyle with diet and exercise alone to changes in lifestyle and exercise in combination with metformin medication. Metformin is a pill that makes the body's insulin work better. When used in combination with improvements in diet and exercise, it can promote weight loss.

To learn more about this study, please visit our link at www.lhsc.on.ca/REACH or contact the coordinator at

Funding for this study is provided by Children's Health Foundation, and the Canadian Institutes of Health Research.

REACH: Dr. Cheril Clarson, Dr. Stewart Harris,
Dr. Michelle Jackman, Dr. Farid Mahmud
Dr. Harry Prapavessis, Dr. Kevin Shoemaker, Justine Wilson

Children's Hospital
London Health Sciences Centre

LAWSON
HEALTH RESEARCH INSTITUTE

Western

EHPL

Appendix B

Date of assessment: __________

Participant ID: __________

Date of birth: ____________

Gender (please circle): Male Female

Outcome Expectations – Social

Instructions:
We would like to know what benefits (good things) you think you will get from **participating in physical activity over the next 4 weeks.** Please decide how likely and how important each possible outcome is to you. Write your answers (a number from 1 to 9) in the box beside the outcome.

Possible Outcomes	How **likely** you think this outcome is to occur.	How **important** this outcome is to you.
Social Outcomes *from participating in physical activity over the next 4 weeks.*	1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 Very unlikely | Somewhat unlikely | Just as likely as unlikely | Somewhat likely | Very likely	1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 Little value to me | Average value to me | Great value to me
1. Socialize with other kids similar to me		
2. Get to be active outside my house		
3. Spend time interacting with new kids		
4. Praise from friends and family for being physically active		

Outcome Expectations – Physical

Instructions:

We would like to know what benefits (good things) you think you will get from **participating in physical activity over the next 4 weeks.** Please decide how likely and how important each possible outcome is to you. Write your answers (a number from 1 to 9) in the box beside the outcome.

	How **likely** you think this outcome is to occur.	How **important** this outcome is to you.
Physical outcomes	1 2 3 4 5 6 7 8 9 Very unlikely (1–2) · Somewhat unlikely (3–4) · Equal likely as unlikely (5) · Somewhat likely (6–7) · Very likely (8–9)	1 2 3 4 5 6 7 8 9 Little value to me (1–2) · Average value to me (3–6) · Great value to me (7–9)
1. Help control my weight		
2. Improve fitness		
3. Get stronger		
4. Have more energy		
5. Help me get rid of body pain		
6. Make me feel better physically		
7. Improve my ability to do daily activities		

Outcome Expectations – Psychological

Instructions:

We would like to know what benefits (good things) you think you will get from participating in physical activity over the **next 4 weeks**. Please decide how likely and how important each possible outcome is to you. Write your answers (a number from 1 to 9) in the box beside the outcome.

Possible Outcomes	How **likely** you think this outcome is to occur.	How **important** this outcome is to you.
Psychological Outcomes	1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 Very unlikely | Somewhat unlikely | Just as likely as unlikely | Somewhat likely | Very likely	1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 Little value to me | Average value to me | Great value to me
1. Decrease stress		
2. Feel more energized		
3. Feel good about my appearance		
4. Help me manage depression		
5. Better overall mood		
6. Enjoyment		
7. Feel accomplished		

Satisfaction - Outcomes

Instructions:

For the following questions please indicate how **satisfied** or unsatisfied you are. **Satisfaction** means how happy or not you are with something.

1. How satisfied are you with your total weight loss?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

2. How satisfied are you with your appearance?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

3. How satisfied are you with your health (how you feel in general)?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

4. How satisfied are you with how you feel **after** you are physically active?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

5. How satisfied are you with how you feel **during** physical activity?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

6. How satisfied are you with how hard you can push yourself during physical activity?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

7. How satisfied are you with how intensely you can engage in physical activity?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

8. How satisfied are you with how quickly you can recover from physical activity? (How fast your heart rate and breathing come back to normal?)

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

Satisfaction – Current State

Instructions:

For the following questions, please indicate how **satisfied** you currently are. **Satisfaction** means how happy or not you are with something.

1. How satisfied are you with your current endurance fitness? (Endurance fitness means how long you can do an activity for.)

Very Unsatisfied — Very Satisfied

-4 -3 -2 -1 0 1 2 3 4

2. How satisfied are you with your current strength fitness? (Strength fitness means how much you can lift, push or pull.)

Very Unsatisfied — Very Satisfied

-4 -3 -2 -1 0 1 2 3 4

3. How satisfied are you currently with the way clothes look and feel on your body?

Very Unsatisfied — Very Satisfied

-4 -3 -2 -1 0 1 2 3 4

4. How satisfied are you currently with your ability to complete household chores?

Very Unsatisfied — Very Satisfied

-4 -3 -2 -1 0 1 2 3 4

5. How satisfied are you with your current social life (doing things with your friends)?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

Satisfaction – Outcomes from REACH Program

Instructions

For the following questions, please indicate, based on the **REACH program only**, how satisfied you are with the following:
Satisfaction means how happy or not you are with something.

1. **Based on the REACH program only,** how satisfied are you with changes in your self-control?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

2. **Based on the REACH program only,** how satisfied are you with changes in your worries about your weight?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

3. **Based on the REACH program only,** how satisfied are you with changes in your frustration about your weight?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

4. **Based on the REACH program only,** how satisfied are you with changes in your self-esteem (how you feel about yourself)?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

5. <u>Based on the REACH program only,</u> how satisfied are you with the support you get from the other group members?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

6. <u>Based on the REACH program only,</u> how satisfied are you with changes in your weight?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

7. <u>Based on the REACH program only,</u> how satisfied are you with changes in your attractiveness?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

8. <u>Based on the REACH program only,</u> how satisfied are you with changes in how clothes fit you?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

9. <u>Based on the REACH program only,</u> how satisfied are you with changes in your current health risks? (For example, a health risk is developing Type 2 Diabetes).

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

10. **<u>Based on the REACH program only,</u>** how satisfied are you with changes in your social life?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

11. **<u>Based on the REACH program only</u>**, how satisfied are you with changes in your ability to be physically active?

Very Unsatisfied								Very Satisfied
-4	-3	-2	-1	0	1	2	3	4

Physical Activity Enjoyment Scale

Instructions:

We are interested in your thoughts and feelings about physical activity. Please think about the physical activity you have been involved in over the past week and respond to the questions about your feelings.

Physical activity over the past week for me has been:

I hate it						I enjoy it
1	2	3	4	5	6	7

I feel bored						I feel interested
1	2	3	4	5	6	7

I dislike it						I like it
1	2	3	4	5	6	7

I find it unpleasurable						I find it pleasurable
1	2	3	4	5	6	7

I am not at all engaged in physical activity						I am very engaged in physical activity
1	2	3	4	5	6	7

It's no fun at all						It's a lot of fun
1	2	3	4	5	6	7

I find it tiring						I find it energizing
1	2	3	4	5	6	7

It makes me depressed						It makes me happy
1	2	3	4	5	6	7

It is very unpleasant						It is very pleasant
1	2	3	4	5	6	7

Physical activity over the past week for me has been:

I feel bad while doing it				I feel good while doing it		
1	2	3	4	5	6	7
It's not very invigorating				It's very invigorating		
1	2	3	4	5	6	7
I am very frustrated				I am not at all frustrated		
1	2	3	4	5	6	7
It's not at all satisfying				It's very satisfying		
1	2	3	4	5	6	7
It's not at all exhilarating				It's very exhilarating		
1	2	3	4	5	6	7
It's not at all exciting				It's exciting		
1	2	3	4	5	6	7
It does not give me a strong sense of accomplishment				It gives me a strong sense of accomplishment		
1	2	3	4	5	6	7
It's not very refreshing				It's very refreshing		
1	2	3	4	5	6	7
I would rather be doing something else				There is nothing else I would rather be doing		
1	2	3	4	5	6	7

Self-efficacy – Goal setting

Instructions:

We would like to know how confident you are with different parts of your physical activity program and your goal setting abilities. The word **'confident'** refers to the belief that you have in yourself that you can do something well. For example, you may have 100% confidence in your abilities to walk to the end of the block, but you may only have 20% confidence that you can run to the end of the block in less than 5 seconds.

For the questions below, please indicate how **confident** you are that you can:

Not at all confident — **Very Confident**

My confidence in my ability to:	0	10	20	30	40	50	60	70	80	90	100
1. Set realistic goals for increasing and maintaining my physical activity **in the next month.**											
2. Develop clear, well thought out plans to reach my physical activity goals **in the next month.**											
3. Follow through with my physical activity plans, even though it may be difficult at times **in the next month.**											
4. Keep trying to achieve my physical activity goals, even though there may be times that I fail **in the next month.**											
5. Develop goals for increasing and maintaining my physical activity **in the next month.**											

Self-efficacy – Planning

Instructions:

Many people say that it is hard to schedule and plan physical activity. Please rate how confident you are at completing the following tasks. The word **'confident'** refers to the belief that you have in yourself that you can do something well.

The amount I am **confident** that I could do the following **regularly over the next 4 weeks is**:

My confidence in my ability to:	0	10	20	30	40	50	60	70	80	90	100
1. Plan to participate in independent physical activity (activities done outside my exercise class) **three times in the next 7 days.**											
2. Plan to participate in independent (other than my exercise class) physical activity **in the next 7 days.**											
3. Arrange my schedule to do independent physical activity regularly no matter what **over the next 7 days.**											
4. Maintain a definite plan to restart my independent physical activity if I should miss any sessions **in the next 7 days.**											
5. Make up times (reschedule) when I miss my regular independent physical activity sessions **over the next 7 days.**											
6. Make sure that I do not miss more than one day of independent physical activity due to other obligations **over the next 7 days.**											
7. Organize my time and responsibilities **over the next 7 days** around each of my independent physical activity sessions.											

Self-efficacy – Physical Activity

WHAT ARE LIGHT / MODERATE / HARD ACTIVITIES?

Below is the description of what light, moderate and hard activities are:

LIGHT ACTIVTIES: Are when you are moving around, but your heart rate and breathing do not increase very much. You probably will not be sweating doing these unless the weather is really hot. You would be able to talk easily through the activity. Examples: ***Slow walking, slow dancing, shooting hoops, tossing a Frisbee, slow bike riding, bowling, stretching***

MODERATE ACTIVITIES: Are when your breathing and heart rate increase. You may start to sweat, your legs might feel a little bit tired and you may feel out of breath. You may also find it hard to talk during the activity.
Examples: ***Brisk walking, moderate dancing, basketball drill (lay-ups), skateboarding, volleyball, softball, baseball, skiing, fast hiking***

HARD ACTIVTIES: Are when your heart beats very fast, your breathing is fast and you start sweating. You may also feel exhausted and out of breath. Your legs would probably be feeling pretty heavy. It would be very hard to talk during the activity.
Examples: ***Running fast, fast stair climbing, fast dancing, basketball game, ultimate Frisbee, bike riding fast uphill, mountain biking, circuit weight training, cross-country skiing, fast swimming, backpacking,***

In answering the following questions you will be asked to think about how confident you are that you can participate in physical activities that are described as light / moderate / hard. The word "confident" refers to the belief that you have in yourself that you can do something well.

LIGHT ACTIVTIES: Are when you are moving around, but your heart rate and breathing do not increase very much. You probably will not be sweating doing these unless the weather is really hot. You would be able to talk easily through the activity.

Examples: **Slow walking, slow dancing, shooting hoops, tossing a Frisbee, slow bike riding, bowling, *stretching***

1. How confident are you that you can complete **10 minutes** of physical activity at a **light** intensity level three times next week?

0% 10%	20% 30%	40% 50%	60% 70%	80% 90% 100%
I am not at all confident	**I am not really confident**	**I am kind of confident**	**I am reasonably confident**	**I am almost certainly confident**

2. How confident are you that you can complete **30 minutes** of physical activity at a **light** intensity level three times next week?

0% 10%	20% 30%	40% 50%	60% 70%	80% 90% 100%
I am not at all confident	**I am not really confident**	**I am kind of confident**	**I am reasonably confident**	**I am almost certainly confident**

3. How confident are you that you can complete **60 minutes** of physical activity at a **light** intensity level three times next week?

0% 10%	20% 30%	40% 50%	60% 70%	80% 90% 100%
I am not at all confident	**I am not really confident**	**I am kind of confident**	**I am reasonably confident**	**I am almost certainly confident**

MODERATE *ACTIVITIES*: Are when your breathing and heart rate increase. You may start to sweat, your legs might feel a little bit tired and you may feel out of breath. You may also find it hard to talk during the activity.

Examples: ***Brisk walking, moderate dancing, basketball drill (lay-ups), skateboarding, volleyball, softball, baseball, skiing, fast hiking***

4. How confident are you that you can complete **10 minutes** of physical activity at a **moderate** intensity level three times next week?

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
I am not at all confident		**I am not really confident**		**I am kind of confident**		**I am reasonably confident**		**I am almost certainly confident**		

5. How confident are you that you can complete **30 minutes** of physical activity at a **moderate** intensity level three times next week?

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
I am not at all confident		**I am not really confident**		**I am kind of confident**		**I am reasonably confident**		**I am almost certainly confident**		

6. How confident are you that you can complete **60 minutes** of physical activity at a **moderate** intensity level three times next week?

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
I am not at all confident		**I am not really confident**		**I am kind of confident**		**I am reasonably confident**		**I am almost certainly confident**		

HARD ACTIVTIES: Are when your heart beats very fast, your breathing is fast and you start sweating. You may also feel exhausted and out of breath. Your legs would probably be feeling pretty heavy. It would be very hard to talk during the activity.

Examples: ***Running fast, fast stair climbing, fast dancing, basketball game, ultimate Frisbee, bike riding fast uphill, mountain biking, circuit weight training, cross-country skiing, fast swimming, backpacking,***

7. How confident are you that you can complete **10 minutes** of physical activity at a **hard** intensity level three times next week?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

I am not at all confident	I am not really confident	I am kind of confident	I am reasonably confident	I am almost certainly confident

8. How confident are you that you can complete **30 minutes** of physical activity at a **hard** intensity level three times next week?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

I am not at all confident	I am not really confident	I am kind of confident	I am reasonably confident	I am almost certainly confident

9. How confident are you that you can complete **60 minutes** of physical activity at a **hard** intensity level three times next week?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

I am not at all confident	I am not really confident	I am kind of confident	I am reasonably confident	I am almost certainly confident

Self-efficacy – Barrier

Rate on the line from 0 - 100% how confident you are that when faced with one of the situations given below, you will still be able to participate in 60 minutes of physical activity most days next week.

1. How confident are you that you **would** still do physical activity if the weather is bad?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

I am not at all confident	I am not really confident	I am kind of confident	I am reasonably confident	I am almost certainly confident

2. How confident are you that you **would** still be physically active if you have a lot of school work to do?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

I am not at all confident	I am not really confident	I am kind of confident	I am reasonably confident	I am almost certainly confident

3. How confident are you that you **would** still be physically active if there are T.V. programs on that you would like to watch instead?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

I am not at all confident	I am not really confident	I am kind of confident	I am reasonably confident	I am almost certainly confident

4. How confident are you that you **would** still be physically active if you have a lot of other commitments to do with your friends and/or family.

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

I am not at all confident	I am not really confident	I am kind of confident	I am reasonably confident	I am almost certainly confident

5. How confident are you that you **would** still be physically active even if you are tired?

0% 10%	20% 30%	40% 50%	60% 70%	80% 90% 100%
I am not at all confident	I am not really confident	I am kind of confident	I am reasonably confident	I am almost certainly confident

6. How confident are you that you **would** still be physically active even if your muscles are sore?

0% 10%	20% 30%	40% 50%	60% 70%	80% 90% 100%
I am not at all confident	I am not really confident	I am kind of confident	I am reasonably confident	I am almost certainly confident

7. How confident are you that you **would** still be physically active even if you don't feel comfortable in gym clothes in front of other people?

0% 10%	20% 30%	40% 50%	60% 70%	80% 90% 100%
I am not at all confident	I am not really confident	I am kind of confident	I am reasonably confident	I am almost certainly confident

Group Cohesion

Instructions:

In answering the following questions you will be asked to think about your current and future relationships with the other participants in the group. Please mark the extent to which you agree or disagree with the following statements.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. The group members help keep everyone motivated to continue being physically active.					
2. The group has helped identify and understand barriers to physical activity that everyone in the group faces.					
3. The group helps me make physical activity a part of my daily life.					
4. Our group discussions about being physically active are providing all of us with a better understanding than just reading about it.					
5. Our group discussions have taught me that I can be physically active on my own once the program is over.					
6. The group will be successful in being physically active on their own once the program is over.					
7. Our group discussions will help me when I have to be physically active on my own.					

GMCB Session Leader Collaboration

Instructions:

Listed below are several questions that relate to your <u>group</u> leader **(JUSTINE)** and the relationship that you have formed with her during group sessions. Please mark to what extent you agree or disagree with each statement by circling a response to each statement.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I feel our discussion leader wants to know about our opinions and values our opinions about fitting the skills we learned into our daily life.					
2. Because of our discussions I feel I have an independent physical activity plan I can do after the program is done.					
3. Our group leader encourages and works with me so I can plan and take responsibility for including physical activity into my life.					
4. I feel our discussion leader and I have worked together in building a physical activity plan that works for my lifestyle.					
5. Our discussion leader cares about my health and about my opinions for developing my own physical activity program.					
6. Because of our discussions I feel I have learned some skills that will help me maintain a physically active lifestyle.					

Exercise Leader Collaboration

Instructions:

Listed below are several questions that relate to your **exercise** (**JUSTINE & SARAH or JACKIE & LOUISE**) leader and the relationship that you have formed with her during exercise sessions. Please mark to what extent you agree or disagree with each statement by circling a response to each statement.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I feel our physical activity leader wants to know about our opinions and values our opinions about fitting the skills we learned into our daily life.					
2. Our physical activity leader encourages and works with me during the exercise sessions so I can plan and take responsibility for including physical activity into my life.					
3. I feel our physical activity leader and I have worked together in building a physical activity plan that works for my lifestyle.					
4. Our physical activity leader cares about my health and about my opinions for developing my own physical activity program.					
5. I feel like I can talk to my physical activity leader about my physical activity program.					
6. I want to impress my physical activity leader.					

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
7. I want to make my physical activity leader happy.					
8. My physical activity leader motivates me to come to class.					
9. My interactions with the physical activity leader make physical activity class more fun.					
10. My physical activity leader has a positive attitude.					
11. My physical activity leader has a fun attitude.					

Appendix C

REACH

Exercise and Healthy Lifestyle Program

MY REACH PROGRESS REPORT CARD

	BASELINE	13 WEEKS	6 MONTHS	1 YEAR	2 YEARS
Attendance Exercise SW/Dietician					
% Body Fat Fat mass (kg) Muscle mass(kg)					
Weight (kg) Height (cm)					
Strength (N/m)					
VO2 Max (aerobic fitness)					

PARTICIPANT ID:

Next assessment:

My REACH Goals

Over the next 3 months, these are my goals that will help me maintain my active, healthy lifestyle:

Physical activity

____

____

____

Nutrition

____

____

____

Appendix D

Week 2

GOAL 1
Review physical activity logs.
Our group goal is to:

____

____

GOAL 2

One of the most important things in becoming a healthier, physically active person, is understanding **why you want to change your behaviour**, why you want to become healthier!

When thinking about why you want to become more active, what would you say is your **MAIN REASON** for wanting to become more active? (In other words, **WHY** do you want to change?)

____

____

____

Why does the group want to become more active?

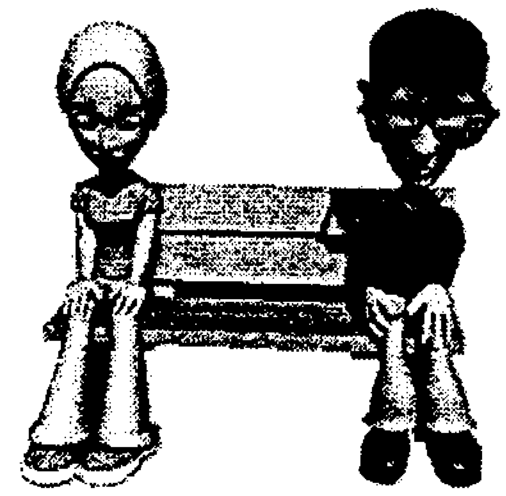
____

____

____

GOAL 3

How does physical activity make me feel?

 **Good Feelings**	**Bad Feelings** 

GOAL 4

Find a buddy and get to know them. What did they do on the weekend? What is something unique about them? What's their favourite TV show?

My buddy's name is:______________________________

How can my buddy help me?

____

This is how I'm going to contact my buddy:

____

____

Week Two Homework Assignment

1. Contact your buddy. Here are some things you can ask them:
    - Did you do any physical activity yesterday?
    - Do you want to get together and go for a bike ride? Go to the park?
    - What's your plans for physical activity for the rest of the week?

2. Continue to track your physical activity over the next week.

Activity Log Week Two

Week 1	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Activity: Intensity: Minutes: Steps:							
Activity: Intensity: Minutes: Steps:							
Activity: Intensity: Minutes: Steps:							

ACTIVITY = What activity did you do?

INTENSITY = How hard was it?
Light, moderate or vigorous?

MINS = How long?

STEPS = If you wore the pedometer, how many steps did you take?

Week 7

Group discussion about why you wanted to be active at the beginning of the program.

Group discussion about why you want to be active now.

Planning

What does planning mean to you?

Why is it important or helpful to plan? Do you plan at school?

For example...

Alexandre Bilodeau - first Canadian athlete to win a gold medal on Canadian soil!

- **Trains 6-8 hours/day**
- **Trains in Quebec and Calgary**
- **Travels all over the world to compete**

You all have very busy lives like this Olympic Champion, and it's important to plan in events and activities that are important to you. Planning will help you REACH your goals. You have all done a great job monitoring your physical activity over the past few weeks. Now we are going to plan physical activity into your daily lives.

Be sure to use the **FITT** principle to fill in the week plan.

TIME	Monday ________	Tuesday ________	Wednesday ________
7			
8			
9			
10			
11			
noon			
1			
2			
3			
4			
5			
6			
7			
8			
9			

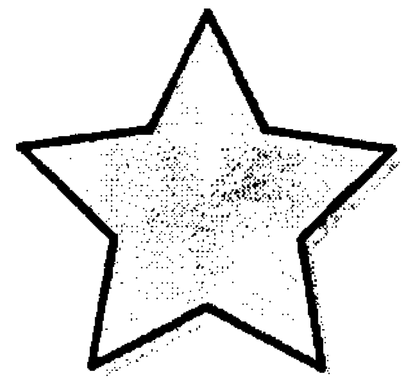
TIME	Thursday ______	Friday ______	Saturday ______	Sunday ______
7				
8				
9				
10				
11				
noon				
1				
2				
3				
4				
5				
6				
7				
8				
9				

After 6 weeks of the program, I am proud of myself for:

____

____

Week Seven Homework Assignment

Use your physical activity plan and put a  at the end of every day if you followed your plan.

Good luck!!!

Appendix E

REACH - Exercise and Healthy Lifestyle Program

DAY 1 - GROUP 1

TIME	ACTIVITY	INSTRUCTORS
430-450	GMCB	Justine
450-510	Cardio Training	Jackie, Louise
510-530	Resistance	Jackie, Louise

- Show participants where they can put their belongings
- Get participants to put on heart rate monitors and watches ASAP (don't turn on yet!)

GMCB session in psych room

Cardio Training

- Ask participants to turn on HR monitors
- Jackie – give 30 sec summary of how to get each machine working, proper technique etc.
- Let participants choose machine they want to go on. Tell them they must stay on for at least 10 minutes before can change machines.
- Exercise leaders walk around – ensure everyone getting machines working, proper technique
    - o 2 min warm-up. Accumulate at least 10 mins at target heart rate (on 1+ machines if have time to switch)
- Only stay in cardio room for 20 mins total (OK if don't get full workout today).
- Goal is to get kids comfortable with at least one machine
- Wipe down machines
- Take off heart rate monitors and watches, put watches on desk in computer room with sticker with participant ID on it. Make sure get in the habit of placing watches on table nicely! Rinse off HR bands. Put back on the wall NEATLY!

Resistance Training

- Start with plank – discuss warming up the core before you start exercising
    - o Show variations – from toes or knees, hold for 15 seconds
- Jackie – to take group through each machine (30 seconds on each) – show how to use each machine. Demo – last 3 reps should be HARD (ie 13, 14, 15 – show them with face!)
- Divide participants into 3 groups with each leader, go through each machine, determine weight for each machine.
- Take participants through all the machines except
- Discuss timing – slow – 2 up/out, 0 rest, 2 down/in

Stretching

- Stretch major muscle groups

DISCUSSION

Ask participants how it was!?? Favorite machines?? How did they feel?

Reach! Exercise and Healthy Lifestyle Program

DAY 1 - GROUP 2

TIME	ACTIVITY	INSTRUCTORS
515-535	GMCB	Justine
535-555	Cardio Training	Justine, Sarah
555-615	Resistance Training	Justine, Sarah

- Show participants where they can put their belongings
- Get participants to put on heart rate monitors and watches ASAP (don't turn on yet!)

GMCB session in psych room

Cardio Training

- Ask participants to turn on HR monitors
- Justine – give 30 sec summary of how to get each machine working, proper technique etc.
- Let participants choose machine they want to go on. Tell them they must stay on for 10 mins before can change machines.
- Exercise leaders walk around – ensure everyone getting machines working, proper technique
    - o <u>2 min warm-up</u>
    - o <u>Accumulate at least 10 mins at target heart rate</u> (on 1+ machines if have time to switch)
- Only stay in cardio room for 20 mins total (OK if don't get full workout today).
- Goal is to get kids comfortable with at least one machine
- Wipe down machines
- Take off heart rate monitors and watches, put watches on desk in computer room with sticker with participant ID on it. Make sure get in the habit of placing watches on table nicely! Rinse off HR bands. Put back on the wall NEATLY!

Resistance Training

- Start with plank – discuss warming up the core before you start exercising
    - o Show variations – from toes or knees, hold for <u>30 seconds</u>
- Justine – to take group through each machine (30 seconds on each) – show how to use each machine. Demo – last 3 reps should be HARD (ie 8, 9, 10 – show them with face!)
- Divide participants into 3 groups with each leader, go through each machine, determine weight for each machine.
- Take participants through all the machines
- Discuss timing – slow – 2 up/out, 0 rest, 2 down/in

Stretching

- Stretch major muscle groups

DISCUSSION

Ask participants how it was!?? Favorite machines?? How did they feel?

REACH Exercise Program

Exercise Session Summary Sheet

Date: ________________ Group: 1

Name	HR Zone	RPE	Attendance

Time in Cardio: ________________ Time in Resistance: ________________

Notes:

____

____

What went well:

____

____

____

Improvements for next time:

____

____

____