Mediators of Behavior Change in Two Tailored Physical Activity Interventions for Adolescent Girls

Participation in regular physical activity is associated with a variety of positive outcomes for young people (Strong et al., 2005). Although many of the physiological benefits of physical activity are difficult to establish during youth (Cavill, Biddle, & Sallis, 2001; Riddoch, 1998), longitudinal studies have consistently demonstrated a positive link between an active lifestyle and a number of favorable outcomes during this period (Boreham et al., 2004; Epstein, Paluch, Gordy, & Dorn, 2000; McMurray et al., 2002). Despite the many benefits of an active lifestyle, physical activity levels decline during adolescence (Sallis, 2000). This decline is more pronounced among adolescent girls, who often opt out of compulsory physical activity at the first opportunity (Caspersen, Pereira, & Curran, 2000; U.S. Department of Health & Human Services, 1996). Adolescent Iranian girls are at a particularly high risk for adopting sedentary behavior due to specific cultural barriers, such as restrictions regarding exercising in public. A recent study of adolescent Iranian girls found that only 36% of individuals were in the adoption stages of physical activity (Taymoori, Niknami, Ghofranipour, & Kazemnejad, 2006).

Schools have been identified as key institutions for the promotion of physical activity among adolescents (Centers for Disease Control & Prevention, 1996; U.S. Department of Health & Human Services, 2000; Wechsler, Devereaux, Davis, & Collins, 2000), as young people spend the majority of their waking hours in the school environment. Furthermore, schools possess the necessary facilities and equipment to promote physical activity. It is therefore no surprise that the majority of physical activity interventions among youth have been evaluated in the school setting (Kahn et al., 2002; Stone, McKenzie, Welk, & Booth, 1998). While most school-based physical activity interventions have evaluated enhanced physical education (PE) programs, there is a growing recognition that interventions should be targeted towards specific groups and be differentiated on the grounds of gender, age and socio-economic status (Cavill et al., 2001).

The design and evaluation of physical activity interventions among youth require careful attention, as the results of previous studies have been unconvincing. Baranowski and Jago (2005) have argued that the low efficacy and effectiveness of interventions may be due to a lack of knowledge regarding the mechanisms responsible for behavior change. In the last decade, the importance placed on theory when designing interventions has increased (Baranowski, Anderson, & Carmack, 1998; Marcus et al., 2006) and most recent interventions have been developed with reference to a behavioral science theory. While it is common for researchers to cite a theoretical framework (e.g. Social Cognitive Theory), very few studies conduct a mediation analysis to identify whether increases in physical activity were a result of changes in the theoretical constructs (Baranowski et al., 1998; Reynolds, Yaroch, Franklin, Maloy, & Reynolds, 2002). Mediation can be established using linear regression and the criteria proposed by Baron and Kenny (1986) or with structural equation modeling.

A mediator can be defined as an intervening causal variable necessary to complete the pathway from an intervention to the targeted behavioral outcome (Bauman, Sallis, Dzewaltowski, & Owen, 2002). More specifically, mediation is established if the positive relationship between an intervention and an outcome is significantly reduced after statistically controlling for the mediator (Baron & Kenny, 1986). The most recent review of physical activity mediation studies found only 10 mediation studies conducted in adult populations and only two studies that involved children or adolescents (Lewis, Marcus, Pate, & Dunn, 2002). The authors concluded that behavioral processes of change (e.g. rewarding yourself, enlisting social support and self-monitoring) were the most consistent mediators of physical activity behaviour among children and adults. They also suggested that self-efficacy was a potential mediator of behaviour. Although there has been an increase in mediation studies in recent years (e.g. Dishman, Motl, Sallis et al., 2005; Dishman et al., 2004), additional research is needed to develop more effective and efficient interventions by identifying the components of interventions that are responsible for behaviour change.

The purpose of this paper is to identify mediators of behavior change in two six-

month tailored physical activity interventions for Iranian adolescent girls. The first intervention was based on Pender's Health Promotion Model (HPM: Pender, Murdaugh, & Parsons, 2002) and the second intervention integrated two processes from the Transtheoretical Model (TTM: Prochaska & DiClemente, 1983) into the HPM. The HPM is derived from Bandura's Social Cognitive Theory (SCT: 1986) and the notion of 'reciprocal determinism', which proposes that behavior change is influenced by environmental factors, personal factors and attributes of the behavior itself. According to the HPM, health behavior determinants can be classified into three groups: (a) individual characteristics and experiences, (b) behavior specific cognitions and affects and, (c) situational/interpersonal influences (Srof & Velsor-Friedrich, 2006). While many background factors (e.g. gender, age, genetics) cannot be modified, behavior-specific cognitions (e.g. self-efficacy, perceived barriers) and interpersonal factors (e.g. social support) can be targeted to improve health behaviors. The HPM shares a number of similar constructs with the SCT, such as perceived benefits and perceived barriers and in both theories, self-efficacy is regarded as a central construct. Like the SCT, the HPM includes behavioral factors (e.g. past behavior) which can be predictive of current behavior through habit formation or because the same determinants are operating at the same time (Garcia, Pender, Antonakos, & Ronis, 1998). A key difference in the two theories is that the HPM includes the concept of competing preferences, which are viewed as alternative behaviors (e.g. watching television) that have powerful reinforcing properties. Competing preferences can derail a health promoting behavior in favor of the competing behavior. The extent to which an individual is able to resist these preferences depends upon his or her ability to self-regulate. The HPM has been used to explain the physical activity behavior of adolescents in cross-sectional and longitudinal studies (Garcia, Norton, & Frenn, 1995; Garcia et al., 1998; Wu & Pender, 2002) and the findings from these studies support the theoretical propositions of the HPM (Srof & Velsor-Friedrich, 2006). For example, the study by Wu and Pender (2002) explained 83% of the variance in physical activity in a large sample of Taiwanese adolescents. Due in part to the inclusion of the competing preferences construct, the HPM appears to hold promise for understanding physical

activity behavior in teenagers.

The TTM proposes that individuals move through a series of stages as they move from problem behaviors to successful behavior change (Biddle & Mutrie, 2001). The TTM includes five stages of change (i.e. precontemplation, contemplation, preparation, action and maintenance) and 10 processes of change that enable individuals to move from one stage to the next. The 10 processes of change can be divided into two categories labeled cognitive/experiential (i.e. consciousness raising, dramatic relief, environmental reevaluation, self-revaluation and social liberation) and behavioral/environmental (counter conditioning, helping relationships, contingency management, self-liberation and stimulus control) (Courneya & Bobic, 2000). Self-efficacy and decisional balance (i.e. pros and cons of a particular behavior) are important constructs in the TTM (Prochaska & Velicer, 1997) and can also be seen in the HPM. For example, the perceived benefits and barriers constructs from the HPM are combined to create decisional balance in the TTM. In both theories, social support from significant others is regarded as an important determinant of physical activity and the TTM includes processes to increase support from others. The TTM provides powerful implications for those attempting to design and implement physical activity interventions and research has demonstrated that retention and recruitment can be improved using stage-matched interventions (Prochaska & Velicer, 1997). While interventions based on the TTM appear to be effective in promoting short-term physical activity behavior, evidence for the long-term effects of interventions based on the TTM is not as convincing (Adams & White, 2003). In an attempt to explain the mechanisms responsible for the decline in physical activity characteristic of adolescence, a sample of Canadian adolescents completed physical activity and TTM questionnaires at baseline and again at a three year follow-up (Nigg, 2001). Although none of the baseline processes predicted exercise behavior at follow-up, analyses revealed that the directions of the pathways were as hypothesized.

Two behavioral processes (counter conditioning and stimulus control) were integrated into an intervention based on the HPM. These processes were selected for integration because

the HPM does not include equivalent processes. While there is limited research describing the influence of specific TTM processes of change on physical activity behavior, it has been suggested that the use of these strategies may be important long-term exercise adherence (Marcus, Rossi, Selby, Niaura, & Abrams, 1992). In an intervention involving 235 sedentary adults, study participants who increased their use of TTM behavioral processes were more likely to achieve recommended physical activity levels (Dunn et al., 1997). The researchers hypothesized that a TTM stage-specific intervention based on the HPM that combined additional processes from the TTM would result in improved exercise adherence compared to an intervention based solely on the HPM.

Method

Participants

Participants were recruited from three, all female, Iranian public secondary schools that were selected randomly from 31 eligible schools of the same socio-economic background. To assess eligibility for the study, participants completed a stage of exercise behavior questionnaire. Individuals were eligible for inclusion if they were in the preparation stage of exercise behavior at baseline and were in grades nine or 10. Based on these criteria, there were 179 eligible participants. From this number, 12 students declined to participate and one could not participate due to physical limitations, leaving 166 participants. The three schools were then randomly allocated to one of three conditions: a stage-specific intervention based on the Health Promotion Model that included processes from the Transtheoretical Model (THP) (n = 59), an intervention based on the Health Promotion Model (HP) (n = 54) and a control group (CON) (n =53). A power calculation based on the Sobel (1982) first-order test indicated that a sample size of 90 was necessary to detect a medium effect size with .80 level of power, assuming .05 significance level (Fritz & MacKinnon, 2007).

Measures

All measures were translated into Persian by a bilingual researcher and then validated using the standard back translation technique, by a native Persian who was also fluent in

English. Instruments were evaluated by five experts (PhD level) in health behavior, exercise psychology and instrument design and then pilot tested for appropriateness. Following the piloting of questionnaires with 115 participants, revisions in wording and presentation were made based on empirical findings and recommendations from participants in the pilot study. Several items that are pertinent to Iranian culture were added to the final instruments. Due to the emphasis in Iranian culture on family bonds and parents as authority figures, items consistent with this theme were included. The following item was added to the self-efficacy scale, "exercise even though I have family chores to complete" and "I don't have my parents' approval", was added to the barriers scale. For the current study, questionnaires were administered to students in their classrooms. A researcher remained in the room during the questionnaire administration and answered any questions.

Physical Activity. Participation in physical activity was assessed using a modified version of the Child/Adolescent Activity Log (CAAL: Garcia, George, Coviak, Antonakas, & Pender, 1997). Minor modifications were made to the CAAL instrument based on the feedback received from the adolescents in the pilot study. The CAAL requires respondents to keep a log of their time spent in physical activity for six consecutive days (Saturday through Thursday). Total physical activity for the six days was divided by six to provide an average number of minutes spent in physical activity each day. The 1-week test-retest reliability of the CAAL with 115 Iranian adolescents was .98.

Hypothesized Mediators of Physical Activity Behavior: Nine potential mediators were assessed in the current study. While the behavioral processes from the SCT/HPM have received the most consistent support for mediating the relationship between theory-based interventions and physical activity behavior (Lewis et al., 2002), the TTM processes of change have not been studied extensively (Plotnikoff, Hotz, Birkett, & Courneya, 2001) and it is not known if they mediate behavior change (Courneya & Bobic, 2000). For these two reasons, one HPM construct (commitment to planning) and two TTM processes (stimulus control and counter conditioning) were included in the mediation analyses. It was hypothesized that the TTM processes would

mediate physical activity in the THP intervention, but not in the HP intervention. Previous studies have found self-efficacy (Dishman et al., 2004) and social support (Neumark-Sztainer, Story, Hannan, Tharp, & Rex, 2003) to be mediators of physical activity among youth . Self-efficacy was assessed as a mediator and three variables representing interpersonal influences from significant others were included in the analysis. While perceived barriers and perceived benefits have not been established as mediators of physical activity behavior among youth, little is known about the predictors of physical activity behavior in the study sample (i.e. Iranian adolescent girls) and these two variables were also included in the mediation analysis.

Hypothesized Cognitive Mediators. Three hypothesized cognitive mediators were assessed; perceived benefits, perceived barriers and self-efficacy. Perceived benefits are defined as positive or reinforcing aspects of physical activity and were examined using a modified version of the scale developed by Garcia and colleagues (1995). The 8-item measure uses a 4-point Likert scale (1 = not at all true to 4 = very true). The 2-week test-retest reliability of the perceived benefits scale was r = .89 and the alpha coefficient was α = .83 in this study. Perceived barriers refer to real or imagined impediments that prevent, or make participation in physical activity difficult and were measured using a modified version of the scale developed by Garcia and colleagues (1995). The 10 items use a 4-point Likert scale ranging from 1 (not at all true) to 4 (very true). The 2-week test-retest reliability of the scale was r = .77 and the alpha coefficient was α = .78 in the study sample. Exercise self-efficacy was assessed using a modified version of an 8-item scale (Garcia et al., 1995), in which respondents were asked to indicate their confidence in their ability to be active in a variety of situations. Items are scored on a 4-point Likert scales ranging from 1 (not at all confident) to 4 (very confident). The 1-week test-retest reliability of the self-efficacy scale was *r* = .77 and the alpha coefficient was α = .90 in the study population.

Hypothesized Interpersonal Mediators. Interpersonal influences were measured using three scales developed by Garcia and colleagues (1995). These include; social support, exposure to models and interpersonal norms. The social support subscale requires respondents to indicate

how much support they receive from family and friends to increase their physical activity. The 24-tem measure uses a 3-point scale (1 = never to 3 = often). The 1-week test-retest reliability of the scale was $r = .84$ and the alpha coefficient was $\alpha = .82$.

The exposure to models scale was used to assess the respondents' perceptions of the activity levels of significant others. Respondents were asked to report how often their family members or peers performed light, medium or hard physical activity. Responses were assessed on 12-items using a 3-point scale from 1 (never) to 3 (often). The 1-week test-retest reliability of the exposure to models scale was $r = .80$ and the alpha coefficient was $\alpha = .84$.

In this study context, interpersonal norms refer to the expectations of significant others to participate in physical activity. This was measured using four items on a 3-point scale, with responses ranging from 1 (never) to 3 (often). One week test-retest reliability for the interpersonal norms scale was $r = .75$ and the alpha coefficient was $\alpha = .72$.

Hypothesized Behavioral Mediators: Two behavioral processes of change from the TTM were assessed in the current study. These were counter conditioning and stimulus control. A third behavior modification strategy from the SCT was also included; commitment to planning. Two subscales from the *Processes of Exercise Adoption* (PEA) questionnaire developed by Marcus and colleagues (Marcus et al., 1992) were used to assess the participants' use of counter conditioning and stimulus control. Responses indicated the extent to which respondents used the two strategies to increase their physical activity. The questionnaire utilized a 5-point Likert scale, with responses ranging from 1 (never) to 5 (repeatedly). Alpha coefficients for the counter conditioning and stimulus control subscales were $\alpha = .70$ and $\alpha = .83$, respectively. In a previous study, the PEA was found to have excellent ($r = .90$) 2-week test-retest reliability (Fahrenwald & Noble Walker, 2003).

The commitment to physical activity planning measure includes a variety of strategies individuals use to increase physical activity, such as goal setting and activity monitoring (Pender, 2007). Respondents are asked to indicate how often they use a variety of strategies to increase their exercise adherence, example item, "I plan specific times for exercise or active

sports in my weekly schedule". The 11-tem scale was scored from 1 (never) to 3 (often). The alpha coefficient for the study sample was $\alpha = .86$ and the 2-week test-retest reliability of the scale was $r = .90$.

Intervention

Participants in both intervention groups (THP and HP) participated in four group educational sessions, four individual counseling sessions and received follow-up phone calls to support behavior change. The THP and HP educational sessions (each session 45-60 minutes) were tailored for individuals in the preparation stage of the TTM and were delivered by a female health education expert. Each education session followed a similar format, which included: lecture, role playing, slides, reminder cards, physical activity planning and the distribution of educational pamphlets. Education sessions focused on the benefits of physical activity and the barriers to an active lifestyle. Attempts were made to increase self-efficacy through goal setting, positive feedback, verbal persuasion and physical activity planning.

In addition to the group sessions, participants in both THP and HP interventions received four individual counseling sessions (20-25 minute) based on personal responses to questionnaires at the fourth, 10th and 18th weeks of the intervention. These sessions provided individuals with an opportunity to set and review their personal goals, identify strategies to overcome barriers and review their social network. Each participant was also provided with a reminder card of her goals and was asked to display the card in a suitable place at home or in her school notebook. Two additional sessions were aimed at educating the participants' mothers and teachers about strategies for behavior change and the importance of social support and modeling. This intervention component was included to provide role modeling for the participants and to help support the participants reach their physical activity goals. During the 22nd week of the intervention, each participant was telephoned by a research assistant to encourage the participant in her physical activity and to further discuss her goals. In the final week of the interventions, the participants, with their mothers and teachers, went mountaineering to further encourage physical activity and social support in the participants.

This activity was chosen because it is a popular past-time in Iran and is accessible to a large proportion of the population.

The THP group also received education on two processes of change from the TTM: counter conditioning and stimulus control. This included information on walking or cycling to school instead of using the bus, getting on or off the bus several blocks away from their destination, taking the stairs instead of the elevator, taking fitness breaks by walking or doing desk exercises and strategies to make the environment more conducive to physical activity. For example, participants were instructed to post motivating notes in their bedrooms to promote activity. This information was delivered at two sessions in the 10th week of the intervention (at the group session and also at the tailored counseling session) and two sessions in the 18th week (group and individual sessions).

Participants in the control group received their usual physical education program. The control group received no educational or counseling sessions but did receive the educational pamphlets after the final follow-up questionnaires were administered.

Procedure

A randomized controlled trial was conducted to examine the effect of the two six-month tailored interventions. Participants were randomized at the school level to an intervention based on the Health Promotion Model with additional components from the Transtheoretical Model (THP), an intervention based on the Health Promotion Model (HP) or a control group (CON). Participants completed questionnaires at baseline, immediately following the study and then six months after the end of the intervention. The research was approved by the Tarbiat Modares University ethics board and the appropriate educational authorities. All participants were provided with written information regarding the study and informed consent was obtained from both parents and participants.

Data analysis

The data were analyzed with SPSS® version 13.0 (SPSS Inc., Chicago, IL). Minutes spent in physical activity were calculated for each student. Average scores for the various scales

were calculated by dividing the total score by the number of items. However, total scores were reported and used in the analyses for the three interpersonal scales. Outcomes were measured at baseline, immediately following the intervention and then again at six months. To control for group differences at baseline, change scores (follow-up score minus baseline score) were used in all analyses. For all analyses, alpha levels were set at $p < .05$ and marginally significant results are also reported ($p < .10$).

To assess for mediation, both interventions (HP and THP) were compared to the control group in separate analyses. The product-of-coefficients (POC) test; which is based on the criteria identified by Baron and Kenny (1986), was used to assess mediation in the current study because it has good statistical power in small samples (MacKinnon, Lockwood, & Hoffman, 1998). To determine whether each variable was a mediator, the following steps identified were completed:

1) The first step was to establish an association between the intervention and physical activity, controlling for baseline. A regression model was used to test and estimate the effect of the intervention on physical activity.
2) The second step was to establish a relationship between the intervention and the hypothesized mediators. Regression models tested and estimated the effect of the intervention on the hypothesized mediators, controlling for baseline measures. Further analyses were only conducted if the program had at least a marginally significant effect ($p < .10$) on the hypothesized mediators.
3) The third step was to establish if the mediators were associated with physical activity, controlling for baseline. Regression models tested the effect of the mediating variables on physical activity.
4) The fourth step was to determine if the relationship between the treatment condition and physical activity was substantially reduced when controlling for the hypothesized mediators. Treatment condition and hypothesized mediators were entered into regression models explaining physical activity. To determine whether the reduction could be

considered 'substantial', the Sobel test was used (Sobel, 1982). The Sobel test uses a formula (z-value = $a*b/\sqrt{(b^2*s_a^2 + a^2*s_b^2}$ in which a = the path from treatment condition to the mediator; s_a = the standard error of a, b = path from the mediator to physical activity; s_b = standard error of b), to examine the indirect effect of the intervention on physical activity via the hypothesized mediators.

Results

The mean age of students was 14.77 (SD = .48) years in the THP intervention, 14.74 (SD = .43) in the HP intervention and 14.87 (SD = .43) in the control group. At baseline, students in the three groups reported similar amounts of time spent in physical activity (THP = 27.16 ± 12.02 min/day, HP = 28.56 ± 11.30 min/day, and CON = 30.63 ± 12.29 min/day). Values for physical activity and hypothesized mediators are reported in Table 1.

The first step of mediation was to determine the effect of the treatment condition on physical activity. When the physical activity changes scores in the THP group were compared to the CON group a significant intervention effect was identified, F (1, 105) = 11.96, $ß$ = .320, p <.01. Similarly, when the HP group physical activity change scores were compared to the CON group using linear regression, the first criteria for mediation was established, F (1, 104) = 5.72, $ß$ = .228, p <.05.

The second step was to examine the relationship between treatment condition and changes in hypothesized mediators in the THP intervention (Table 2). Linear regression analysis indicated that the intervention group reported increased self-efficacy ($ß$ = .198, p <.05) and increased perceived benefits ($ß$ = .212, p <.05), at follow-up. Those in the intervention group also reported fewer barriers to physical activity ($ß$ = -.303, p <.01) and increased commitment to planning ($ß$ = .408, p < .001). There were no statistically significant differences between intervention and control groups for any of the hypothesized interpersonal mediators (i.e. exposure to models, social support and interpersonal norms) or counter conditioning. However, there was a marginally significant difference between groups for stimulus control ($ß$= .170, p < .10). Only two variables satisfied the second criteria for

mediation in the HP intervention (Table 3). The HP intervention had a significant impact on self-efficacy (ß = .250, $p < .05$) and commitment to planning (ß = .350, $p < .001$) and there was a marginally significant relationship between intervention condition and exposure to modeling (ß = .169, $p < .083$).

The third step of mediation was to identify the relationship between changes in the hypothesized mediators and changes in physical activity (Table 4). Changes in perceived benefits (ß = .443, $p < .001$), perceived barriers (ß = -.554, $p < .001$), self-efficacy (ß = .687, $p < .001$), commitment to planning (ß = .473, $p < .001$) and stimulus control (ß = .309, $p < .01$), were all related to changes in physical activity in the THP intervention. In the HP intervention (Table 5), changes in both self-efficacy (ß = .665, $p < .001$) commitment to planning (ß = .405, $p < .001$) and exposure to modeling (ß = .232, $p < .05$) were related to changes in physical activity.

The final step was to determine if the relationship between the intervention and physical activity was attenuated after controlling for the mediators. Treatment condition (THP) and hypothesized mediators were entered into regression models explaining changes in physical activity. In the first model, both treatment condition, ß = .236, $p < .01$ and perceived benefits ß = .393, $p < .001$ were significant predictors of physical activity. The pathway between treatment condition and physical activity was reduced from ß = .320 to ß = .236, when both treatment and perceived benefits were entered. To determine whether this reduction was significant, the Sobel test was applied (Table 4). The Sobel test was significant ($p < .01$), suggesting that perceived benefits satisfied the fourth criteria for mediation.

Treatment condition ß = .167, $p < .05$ and perceived barriers ß = -.503, $p < .001$, were both significant predictors in the second model explaining physical activity. There was a large reduction in the contribution of treatment (ß = .320 to ß = .167) and subsequently, perceived barriers satisfied the fourth criteria for mediation as determined by the Sobel test. Self-efficacy was also found to satisfy the fourth criteria for mediation with the contribution of treatment reduced from ß = 320 to ß =.191, after its inclusion.

Changes in commitment to planning (ß = .410, p <.001) satisfied the fourth criteria for mediation, after the contribution of treatment condition was reduced from ß = .320 to ß = .152, p >.05. When stimulus control was included in the final regression model, the contribution of treatment reduced from ß = .320 to ß = .275. The Sobel test was nonsignificant, suggesting that changes in stimulus control could not satisfy the fourth criteria for mediation.

Both self-efficacy and commitment to planning satisfied the fourth criteria for mediation in the HP intervention. The inclusion of self-efficacy in the regression model reduced the contribution of treatment condition from ß = .228 to ß = .195, which was regarded as substantial by the Sobel test (p < .05). Similarly, the inclusion of commitment to planning in the regression model substantially reduced (p < .001) the impact of treatment condition to ß = .098. Changes in exposure to modeling could not satisfy the fourth criteria for mediation and the Sobel test was nonsignificant (p = .179)

Discussion

The purpose of this study was to identify mediators of behavior change in two physical activity interventions for adolescent girls. Mediation studies are important for the development of more efficient and effective interventions (Judd & Kenny, 1981), because they enable researchers to reinforce important intervention components and relegate unnecessary ones (MacKinnon & Dwyer, 1993). In the current study, perceived benefits, perceived barriers, self-efficacy and commitment to planning, satisfied the criteria for mediation in the THP intervention and self-efficacy and commitment to planning were identified as mediators in the HP intervention. None of the interpersonal variables assessed in the study were found to mediate physical activity behavior change in either intervention and the two processes from the TTM (stimulus control and counter conditioning) also could not satisfy the criteria for mediation. Many of these findings correspond to the results of previous studies, while others provide additional insight into the mechanisms responsible for behavior change in physical activity interventions.

Although there have been few adolescent physical activity intervention studies that have tested mediation using the methods identified by Baron and Kenny (1986) and Judd and Kenny (1981), recent studies have used structural equation modeling to establish mediation in adolescent populations. These studies have identified constructs from Bandura's SCT as mediators of behavior change among adolescent girls. Previously established mediators include: self-efficacy (Dishman et al., 2004), enjoyment of physical activity (Dishman, Motl, Saunders et al., 2005) and self-management strategies, including goal setting (Dishman, Motl, Sallis et al., 2005; Dishman et al., 2006).

In the current study, changes in perceived benefits were found to mediate behavior change in the THP intervention. This is a novel finding, as previous research among adolescents has suggested that the relationship between cognitions regarding the benefits of activity and the behavior itself is indeterminate (Sallis, Prochaska, & Taylor, 2000). Moreover, studies that evaluated the mediational effect of changes in beliefs on physical activity have not found a statistically significant mediation effect (Dishman, Motl, Sallis et al., 2005; Dishman et al., 2004). For example, outcome expectancy was not associated with changes in physical activity in a study of adolescent girls (Dishman, Motl, Sallis et al., 2005). While changes in awareness and knowledge do not guarantee changes in behavior, they may be an important first step (Biddle & Mutrie, 2001). The identification of perceived benefits as a mediator in the current study may be related to the study participants, who were Iranian adolescent girls. It may be that Iranian adolescent girls have not been provided with strong messages regarding the benefits of physical activity from school and media sources. Such information is helpful in promoting activity in the early stages of exercise adoption when participants are contemplating behavior change. Unlike other physical activity intervention studies with adolescent girls, all participants were generally low-active (i.e. students in both intervention groups reported less than 30 minutes of physical activity per day at baseline) and were in the preparation stage of physical activity adoption at baseline. While both intervention groups received similar education sessions regarding the benefits of physical

activity, perceived benefits did not satisfy the criteria for mediation in the HP intervention. It is possible that the additional information regarding counter conditioning and stimulus control, received by individuals in the THP group contributed to increased perceptions regarding the benefits of physical activity, which in turn, helped mediate physical activity behavior change. The use of structural equation modeling may help to elucidate these relationships in future studies.

Changes in self-efficacy were also found to mediate changes in physical activity behavior in both interventions (THP and HP). This finding corresponds to the results from the Lifestyle Education for Activity Program (LEAP) intervention (Dishman et al., 2004), which demonstrated that changes in self-efficacy were partially responsible for increased physical activity among adolescent girls. However, another longitudinal study found that self-efficacy did not predict change in physical activity over a one year period among adolescent girls (Motl et al., 2005). Self-efficacy is an important construct responsible for behavior change in the HPM and the TTM and has the strongest association with physical activity in almost every study that assesses it (Sallis & Owen, 1999). Another construct related to self-efficacy is perceived barriers, which refer to real or imagined obstacles to an active lifestyle (e.g. not enough time). It is not surprising that an increase in self-efficacy in the intervention group was also associated with a decrease in perceived barriers, which satisfied the criteria for mediation.

While beliefs about overcoming barriers should predict exercise adoption, beliefs about behavior self-regulation should predict long term exercise adherence (Bandura, 1997; Dishman, Motl, Sallis *et al.*, 2005). In the current study, an increased commitment to planning for physical activity was found to mediate changes in physical activity in both interventions. The planning construct includes behaviors such as goal setting, activity monitoring and organisation. The role of these strategies in physical activity adoption and maintenance among adolescents has not been studied extensively (Shilts, Horowitz, & Townsend, 2004). However, in a cross-sectional study of adolescent girls, the use of physical activity self-

management strategies was found to mediate both physical activity and self-efficacy (Dishman, Motl, Sallis et al., 2005). Additional support for efficacy of commitment to planning strategies can be seen in the LEAP study, which found that goal setting mediated self-efficacy, which in turn mediated physical activity behavior (Dishman et al., 2006).

The other two behavioral constructs assessed; stimulus control and counter conditioning, did not satisfy the criteria the criteria for mediation in the two interventions. The relationships among the processes of change, self-efficacy, pros and cons are unclear (Courneya & Bobic, 2000) and it is not yet known if the processes of change from the TTM lead to changes in the mediators (e.g. self-efficacy) which then impact upon physical activity or the processes of change act as independent mediators of physical activity behavior. As mentioned previously, the use of structural equation modeling may help to explain these processes in more detail.

It is interesting to note that none of the interpersonal variables satisfied the criteria for mediation in this study. Although students in both intervention groups reported more social support and exposure to models and improved norms, these changes were not large enough to satisfy criteria two of the Baron Kenny test for mediation. Parental support for physical activity has been identified as an important correlate of physical activity among adolescents (Sallis et al., 2000) and the recent National Longitudinal Study of Adolescent Health revealed that parental influences mediated changes in physical activity over a one year period (Ornelas, Perreira, & Ayala, 2007). Ornelas and colleagues concluded that family cohesion and parental engagement were important for increasing physical activity during adolescence. Both interventions involved a component which required participants' teachers and mothers to encourage the participants to be more active and to express their expectations to the girls. Clearly, social support was a crucial component of this intervention; however, it appears that the intervention did not do enough to impact on these constructs. As there were small increases in the social constructs, an additional explanation could be that the lack of statistical significance was due to the sample size.

While this study has provided important insight into the mechanisms responsible for behavior change in two interventions for adolescent girls, there are a number of limitations that should be noted. First, this study relied on self-report physical activity data, which can provide an overestimation of physical activity. Many physical activity questionnaires require individuals to recall physical activity over a seven day period, which can be a difficult task, relying heavily on memory skills. The CAAL, used in the current study, requires respondents to keep a physical activity diary for six days, which reduces the impact of memory and provides higher quality data. Second, the sample size was not large enough to detect small changes in the hypothesized mediators. While the power calculation based on the Sobel test suggested that a sample size of 90 was necessary to establish mediation, based on a medium effect size, additional constructs may have satisfied mediation in a larger sample. Finally, this study only involved participants in the preparation stage of exercise adoption and did not include adolescents not wanting or intending to increase their physical activity.

This study has a number of strengths which also should be noted. First, this is one of the few adolescent physical activity interventions to find intervention effects at a long-term follow-up, suggesting that both interventions were successful in sustaining behavior change. In many studies, physical activity decreases after an initial increase, once the support of the intensive intervention is removed (Dzewaltowski, Estabrooks, & Glasgow, 2004). Second, this study was successful in establishing mediation in a sample of adolescents. While mediators are often present in intervention studies, they are inadequately described and rarely tested (Reynolds et al., 2002).

Conclusion

None of the interpersonal factors satisfied the criteria for mediation, suggesting that the intervention components designed to increase social support, were either unnecessary or ineffective in facilitating behavior change. However, a number of cognitive and behavioral processes were identified as mediators of behavior change. This study provides additional support for the efficacy of behavioral strategies to increase physical activity, such as goal

setting, activity monitoring and planning. It has been suggested that these behavioral strategies are important for maintaining an active lifestyle, once the behavior has been adopted.

The authors suggest that the impact of the interventions on these constructs may be due to characteristics of the study sample, who were inactive or irregularly active Iranian adolescent girls. While changes in outcome and efficacy beliefs mediated behavior change in the study sample, it is not certain that these findings can be applied to Western countries. For example, it is hypothesized that perceived benefits of physical activity mediated behavior change in the current study because Iranian adolescent girls have not had physical activity messages reinforced through the school and the media, to the same extent as their Western equivalents.

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Table 1: Specific Values for Pretest, Posttest and Change Scores for Physical Activity and Hypothesized Mediators

Variable	Range	Baseline			6-month follow-up			Change scores		
		THP	HP	CON	THP	HP	CON	THP	HP	CON
		(n = 59)	(n = 54)	(n = 53)	(n = 56)	(n = 54)	(n = 51)	(n = 56)	(n = 54)	(n = 51)
Physical activity	Unlimited	27.88	28.56	30.63	59.45	56.79	46.26	32.23	28.24	15.56
		(11.92)	(11.30)	(12.29)	(25.05)	(27.58)	(21.87)	(24.15)	(29.72)	(24.48)
Hypothesized cognitive mediators										
Perceived benefits	1-4	2.58	2.88	2.73	3.41	3.38	3.22	.82	.50	.49
		(.67)	(.62)	(.63)	(.46)	(.46)	(.46)	(.76)	(.85)	(.80)
Perceived barriers	1-4	2.89	2.72	2.94	1.97	2.01	2.45	-.94	-.71	-.48
		(.53)	(.51)	(.55)	(.47)	(.48)	(.52)	(.70)	(.77)	(.75)
Self-efficacy	1-4	1.46	1.46	1.45	1.97	2.03	1.64	.49	.59	.19
		(.46)	(.44)	(.44)	(.70)	(.65)	(.54)	(.81)	(.82)	(.69)
Hypothesized interpersonal mediators										
Exposure to models	12-36	11.45	9.91	10.58	12.45	11.89	10.25	.96	1.98	.06
		(4.15)	(4.23)	(3.92)	(3.29)	(4.58)	(4.47)	(4.66)	(5.97)	(5.48)
Social support	24-72	42.73	42.56	43.42	49.05	48.91	46.31	6.09	5.85	3.08
		(7.49)	(6.93)	(7.71)	(6.78)	(8.07)	(7.11)	(9.83)	(11.01)	(10.64)
Interpersonal norms	4-12	4.15	3.93	3.43	4.79	5.20	4.53	.73	1.28	1.06
		(2.03)	(2.16)	(1.90)	(1.55)	(2.22)	(1.77)	(2.48)	(3.24)	(2.51)
Hypothesized behavioral mediators										
Commitment to planning	1-3	1.63	1.56	1.64	2.07	2.02	1.67	.46	.46	.03
		(.39)	(.52)	(.31)	(.38)	(.44)	(.35)	(.50)	(.68)	(.48)
Stimulus control	1-5	3.39	3.46	3.07	3.93	3.90	3.30	.56	.44	.17
		(1.01)	(.83)	(.98)	(.70)	(.74)	(.87)	(1.19)	(1.07)	(1.12)
Counter conditioning	1-5	2.97	3.00	2.64	3.36	3.29	2.72	.37	.29	.04
		(.96)	(.83)	(.98)	(.73)	(1.01)	(.85)	(1.28)	(1.22)	(1.21)

Note. THP = Intervention based on the Health Promotion and Transtheoretical models, HP = Intervention based on Health Promotion Model and CON = Control.
Means reported and standard deviations in brackets.

Table 2: Effect of Treatment Condition on Hypothesized Mediator Variables in THP Intervention

Variable	***Beta***	**p-*value***	***Confidence interval***
Hypothesized cognitive mediators			
Perceived benefits	.212	.028*	.037 to .636
Perceived barriers	-.303	.002**	-.732 to -.178
Self-efficacy	.198	.040*	.013 to .591
Hypothesized interpersonal mediators			
Exposure to models	.090	.358	-1.038 to 2.849
Social support	.147	.131	-.912 to 6.934
Interpersonal norms	-.066	.500	-1.284 to .631
Hypothesized behavioral mediators			.
Commitment to planning	.408	.000***	248 to .627
Stimulus control	.170	.079	-.047 to .839
Counter conditioning	.131	.178	-.151 to .805

Note. Significance, *$p < .05$, ** $p < .01$, *** $p < .001$
THP = Intervention based on the Health Promotion and Transtheoretical models

Table 3: Effect of Treatment Condition on Hypothesized Mediator Variables in the HP Intervention

Variable	***Beta***	**p-*value***	***Confidence interval***
Hypothesized cognitive mediators			
Perceived benefits	.009	.927	-.303 to .332
Perceived barriers	-.140	.152	-.506 to .080
Self-efficacy	.250	.010*	.095 to .676
Hypothesized interpersonal mediators			
Exposure to models	.169	.083	-.256 to 4.142
Social support	.136	.163	-1.221 to 7.155
Interpersonal norms	.038	.696	-.895 to 1.336
Hypothesized behavioral mediators			
Commitment to planning	.350	.000***	.210 to .663
Stimulus control	.110	.261	-.182 to .664
Counter conditioning	.099	.311	-.226 to .704

Note. Significance, *$p < .05$, ** $p < .01$, *** $p < .001$
HP = Intervention based on the Health Promotion Model

Table 4: Effect of Mediator Variables on Physical Activity Controlling for Baseline in THP Intervention

Variable	***Beta***	**p-*value***	***Confidence interval***
Hypothesized cognitive mediators			
Perceived benefits	.443	.000***	8.686 to 19.843
Perceived barriers	-.554	.000***	-.721 to -.430
Self-efficacy	.687	.000***	18.292 to 27.697
Hypothesized behavioral mediators			
Commitment to planning	.473	.000***	14.356 to 30.563
Stimulus control	.309	.001**	2.754 to 10.829

Note. Significance, *$p < .05$, ** $p < .01$, *** $p < .001$
THP = Intervention based on the Health Promotion and Transtheoretical models

Table 5: Effect of Mediator Variables on Physical Activity Controlling for Baseline in HP Intervention

Variable	***Beta***	**p-*value***	***Confidence interval***
Hypothesized cognitive mediators			
Self-efficacy	.665	.000***	18.700 to 29.156
Hypothesized interpersonal mediators			
Exposure to models	.232	.016*	.210 to 2.040
Hypothesized behavioral mediators			
Commitment to planning	.405	.000***	10.151 to 25.997

Note. Significance, *$p < .05$, ** $p < .01$, *** $p < .001$
HP = Intervention based on the Health Promotion Model

Table 6: Sobel Test for Mediation in the THP intervention

Variable	*a*	s_a	*b*	s_b	z- *value*	p-*value*
Hypothesized cognitive mediators						
Perceived benefits	.336	.151	12.651	2.795	1.997	.005**
Perceived barriers	-.455	.140	-17.076	2.854	2.856	.004**
Self-efficacy	.302	.146	21.727	2.349	2.019	.004**
Hypothesized behavioral mediators						
Commitment to planning	.437	.096	19.507	4.441	3.161	.002**
Stimulus control	.396	.223	5.764	1.990	1.513	.130

Note. a = raw (unstandardized) regression coefficient for the association between intervention and mediator.
s_a = standard error of *a*.
b = raw coefficient for the association b/w mediator and physical activity (when THP intervention is also included).
s_b = standard error of *b*.
Significance, **p* < .05, ** *p* < .01, *** *p* <.001

Table 7: Sobel Test for Mediation in the HP intervention

Variable	***a***	s_a	***b***	s_b	**z-** ***value***	**p-*value***
Hypothesized cognitive mediators						
Self-efficacy	.385	.146	23.331	2.726	2.520	.012*
Hypothesized interpersonal mediators						
Exposure to modeling	1.943	1.109	.966	.461	1.344	.179
Hypothesized behavioral mediators						
Commitment to planning	.436	.114	16.539	4.265	2.723	.006**

Note. a = raw (unstandardized) regression coefficient for the association between intervention and mediator.
s_a = standard error of *a*.
b = raw coefficient for the association b/w mediator and physical activity (when HP intervention is also included)
s_b = standard error of *b*.
Significance, **p* < .05, ** *p* < .01, *** *p* <.001