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An investigation of psychosocial factors related to changes in physical activity and fitness among female adolescents

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Abstract

Research examined the effects of a supervised physical activity program on potential psychosocial mediators and determined whether changes in these psychosocial variables predicted changes in physical activity and fitness. Sedentary adolescent females were assigned to an intervention ($n = 79$) or comparison ($n = 67$) group. Cardiovascular fitness (cycle ergometer), physical activity (3-Day Physical Activity Recall), and psychosocial variables related to physical activity (i.e., self-efficacy, perceived barriers, social support, enjoyment) were assessed at three time points over the 9-month study. An intention-to-treat analysis showed that the intervention did not impact any of the psychosocial variables, with the exception of perceived barriers, which increased in the intervention group. Longitudinal analyses showed that improvements in fitness were associated with positive changes in global self-efficacy and exercise enjoyment. Psychosocial variables did not mediate the program's effects on fitness or activity. However, individual level changes in psychosocial variables were related to changes in cardiovascular fitness.

Keywords: *Physical activity, fitness, adolescents, psychosocial variables, mediators, intervention research*

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Introduction

Despite heightened awareness about the health risks associated with a sedentary lifestyle, rates of physical inactivity among adolescents in the United States are on the rise (YRBSS, 2006). The prevalence of inactivity is particularly high among adolescent females, with almost 10% fewer females meeting recommendations for regular activity than adolescent males by the time they reach the 12th grade (Grunbaum et al., 2004). The severity of this situation has triggered public health interest in developing interventions aimed at preventing age-related declines in activity, and therefore reducing the risks of numerous chronic diseases associated with sedentary behavior (Erlichman, Kerbey, & James, 2002; Kriska, 2003). Given the elevated risk that females face for health problems due to physical inactivity, understanding how to develop intervention programs that specifically target adolescent females is particularly important.

A valuable step in designing effective physical activity intervention programs for adolescent females involves the identification of key intervening variables that may explain behavior change (Baranowski, Anderson, & Carmack, 1998; Bauman, Sallis, Dzewaltowski, & Owen, 2002). Information about the intermediary processes involved in behavior change is important for the replication of successful interventions. To date, research has examined a number of cognitive and behavioral processes associated with changes in physical activity, of which commonly considered variables include self-efficacy, social support, and enjoyment (Biddle, Whitehead, O'Donovan, & Nevill, 2005; Lewis, Marcus, Pate, & Dunn, 2002). These variables generally adhere to the framework proposed by Social-Cognitive Theory (SCT) (Bandura, 1986) that underscores the joint impacts of environmental, personal, and behavioral factors on individual health behavior.

A growing body of research has attempted to identify key mediators of physical activity change among adolescent females. For example, Project Lifestyle Education for Activity Program (LEAP), a school-based physical activity intervention targeting adolescents (ages 12–14 at baseline), studied female high school students of all activity levels, and found that changes in perceived behavioral control predicted changes in physical activity (Motl et al., 2005). Moreover, intervention-related changes in physical activity as a result of Project LEAP were associated with changes in self-efficacy (Dishman et al., 2004) and enjoyment (Dishman et al., 2005). These studies provide initial evidence for an intermediary role of psychosocial variables in physical activity change among adolescent females. Specifically, they support the hypothesis that perceived behavioral control, self-efficacy, and enjoyment of physical activity may mediate the impact of a school-based intervention on self-reported activity levels.

These reports do not, however, address the question of whether psychosocial variables are equally potent behavioral intermediaries among that segment of the adolescent population most in need of intervention: sedentary adolescent females. Two recent studies by Neumark-Sztainer and colleagues (Neumark-Sztainer, Story, Hannan, & Rex, 2003a; Neumark-Sztainer, Story, Hannan, Tharp, & Rex, 2003b), directly address the issue of whether psychosocial variables account

for the impact of a school-based physical activity promotion intervention among sedentary female adolescents. Results of the New Moves program, a one-semester intervention, showed no evidence for the hypothesis that the intervention was mediated by psychosocial variables derived from SCT, including self-efficacy and enjoyment (Neumark-Sztainer et al., 2003a). However, longitudinal analysis of the study participants (control and intervention combined) over a two-semester period found that changes in physical activity did correlate with changes in time constraints and peer support for physical activity (Neumark-Sztainer et al., 2003b). As a whole, these two studies raise questions concerning which psychosocial variables, if any, may explain physical activity behavior change in low-active adolescent females, and what period of observation may be required to evidence these effects. Further, these studies do not consider the extent to which psychosocial variables explain changes in important physiological indicators of health such as cardiovascular fitness.

To address these questions, the present study was designed to examine the effect of a two-semester school-based physical activity intervention on potential psychosocial mediators of behavior and fitness change among sedentary adolescent females. Given that mediation of school-based interventions by psychosocial variables has been previously difficult to demonstrate, we also used a longitudinal approach, examining whether within-person changes in psychosocial variables predict longitudinal changes in physical activity and cardiovascular fitness.

Methods

Recruitment

Recruitment materials including flyers, mailers, posters, and announcements were distributed at two public high schools in Southern California. Materials specified that participants must not be a member of a sports team or club and not be a regular exerciser. Inclusion criteria were: (1) enrollment in the 10th or 11th grade, (2) participation in insufficient levels of physical activity to maintain cardiovascular fitness (i.e., fewer than three 20-min bouts per week of vigorous physical activity and fewer than five 30-min bouts per week of moderate physical activity), (3) performance at or below the 75th percentile of predicted cardiovascular fitness, and (4) ability to exercise without restrictions.

Participants

After completing baseline assessments, 146 eligible participants were enrolled in the study [$n=79$ (intervention); $n=67$ (comparison)]. Of this number, 122 ($n=63$ intervention and $n=59$ comparison) successfully completed the 9-month study (Figure 1). A number of reasons accounted for study attrition including scheduling conflicts, moving away or changing schools, joining sports teams, school suspension, poor class attitude, scheduling conflicts during the test sessions, and loss of interest in the study. Additionally, participants were removed

Figure 1. Participant flow-chart.

from the intervention if they missed more than 10 days of the physical education (PE) class in the first two months of the study. Data were collected for three cohorts across three consecutive years: $n = 43$ (year 1), $n = 39$ (year 2) and $n = 40$ (year 3).

Intervention

Students at two high schools were assigned to the intervention or comparison group, based on the school that they attended. Assignment was non-random. Study recruitment occurred after their school had been assigned to one group

or the other, so participants were informed in advance whether or not they would be participating in the intervention. Members of the comparison group were not provided with any particular instructions with regards to participating in physical activity, and school records were reviewed in order to determine whether they were enrolled in school-based PE during the course of the study.

The intervention was designed to increase students' overall levels of physical activity and cardiovascular fitness through supervised in-class physical activity, health education, and internet-based self-monitoring. The intervention class met five days per week for 60 min each day (approximately 40 min of activity time), with one day per week being devoted to an educational component. Class activities included yoga, aerobics, basketball, swimming, weight training, hip-hop dance, soccer, walking, and kickboxing. The weekly lectures and discussions addressed topics such as time management, body image, motivation, nutrition, and strength training. Several known psychosocial correlates of physical activity were targeted for change, including self-efficacy, social support, perceived barriers, and enjoyment of exercise (Petosa, Hartz, Cardina, & Suminski, 2005). The intervention was designed to increase self-efficacy by providing participants with structured physical activity experiences that increased gradually in aerobic intensity and skill difficulty level throughout the year. Social support for exercise was strengthened by promoting positive communication, teamwork, and encouragement between peers. Strategies for overcoming barriers to being physically active (e.g., lack of time, fatigue) were addressed during the weekly lectures and discussions. In addition, steps were taken to make the intervention class more enjoyable than a regular PE class: students were exempted from standard PE requirements to wear a uniform and to complete a periodic-timed mile run. Class activities were also chosen to be enjoyable. Additional information about the intervention has been provided elsewhere (Jamner, Spruijt-Metz, Bassin, & Cooper, 2004).

Assessments

Physical activity, cardiovascular fitness, and self-reported psychosocial correlates of physical activity (e.g., perceived barriers, enjoyment, self-efficacy) were assessed at three time points: Time 1 (during summer), Time 2 (at the end of fall semester), and Time 3 (at the end of spring semester). Efforts were made to encourage participants who had dropped out or had been removed from the study to complete the remaining assessments. The study protocol was reviewed and approved by the university's Institutional Review Board, all participants provided written informed assent, and their parents or guardians gave written informed consent.

Measures

Physical activity recall. Self-reported physical activity was measured using a 3-Day Physical Activity Recall (3DPAR) validated by Motl, Dishman, Dowda and Pate (2004). Participants recalled their activity for the previous three days

between 7:00 am and 11:30 pm, segmented into 30-min intervals. Activities were converted into Metabolic Equivalents (METs) using the compendium published by Ainsworth et al. (1993), and grouped to calculate the number of daily METs expended in vigorous activity (>6 METs). Research focused on vigorous activity because the instruments assessing the psychosocial variables (e.g., self-efficacy and perceived barriers) targeted activity that was defined as vigorous or described as exercise that caused an increase in heart rate and breathing. At baseline, participants were on summer vacation and completed the 3DPAR for the three days leading up to their clinic visit, which was arranged according to their availability. For the subsequent assessments, which occurred during the school year, one weekday and two weekend days were assessed. We chose to emphasize weekend days in order to assess physical activity taking place during students' discretionary time. Steps were taken to ensure that the 3DPAR included a weekday when the class engaged in a discussion, rather than supervised activity. Therefore, the 3DPAR excluded any supervised activity that was part of the intervention.

Cardiovascular fitness. Cardiovascular fitness was obtained through a ramp-type progressive exercise test on an electronically braked cycle ergometer (Whipp, Davis, Torrers, & Wasserman, 1981). After a 3-min warm-up with unloaded pedaling (i.e., 0 W), the power output increased in a progressive fashion (i.e., 15 W min^{-1}). Participants were encouraged to maintain a pedaling rate of 70 rev min^{-1} during the test phase of the protocol. The ramp power output increased continuously until participants reached voluntary fatigue. The duration of the test portion of the protocol lasted between 8–12 min. Each test was followed by an appropriate cool down period.

Peak oxygen consumption (VO_2 peak in $\text{ml min}^{-1} \text{ kg}^{-1}$) was obtained using the SensorMedics Vmax 229 metabolic cart (Yorba Linda, CA), through a method previously designed for children and adolescents (Cooper, Weiler-Ravell, Whipp, & Wasserman, 1984). Gas exchange was measured breath-by-breath throughout the exercise protocol (Beaver, Lamarra, & Wasserman, 1981).

Psychosocial variables related to physical activity. Instruments assessing psychosocial factors related to physical activity are described in Table I. Variables were chosen to reflect important predictors of behavior based on SCT (Bandura, 1986) and included self-efficacy, social support, perceived barriers, and enjoyment. All of the measures have been employed in research focusing on adolescents and college students. The instruments assessing self-efficacy (Dwyer, Allison, & Makin, 1998), perceived barriers (Allison, Dwyer, & Makin, 1999), and enjoyment (Motl et al., 2001) have demonstrated acceptable measurement properties in adolescent samples. The social support instrument has been successfully used among college students (e.g., Sallis, Calfas, Alcaraz, Gehrman, & Johnson, 1999).

Table I. Instruments assessing psychosocial variables related to physical activity.

Variable	Brief description of instrument	Internal consistency ^a
Self-efficacy for PA	Twenty-two item instrument developed by Dwyer et al. (1998). One item assessed global self-efficacy to participate in vigorous physical activity at least three times a week. Eleven items assessed self-efficacy to overcome internal barriers to physical activity such as lacking athletic ability and feeling self-conscious. Ten items assessed self-efficacy to overcome external barriers such as a lack of programs and facilities. Responses were on a scale of 1 (<i>Not at all confident</i>) to 5 (<i>Very confident</i>).	Internal self-efficacy ($\alpha = 0.85$). External self-efficacy ($\alpha = 0.81$).
Social support for PA	Twenty-four item instrument developed by Sallis, Grossman, Pinski, Patterson, and Nader (1987). Respondents indicated the frequency with which family and friends engaged in various supportive acts over the past three months (e.g., "offered to do physical activities with me"). Items were scored on a scale of 1 (<i>None</i>) to 5 (<i>Very often</i>). Separate scores were obtained for family and friends.	Family support ($\alpha = 0.80$). Friend support ($\alpha = 0.79$).
Perceived barriers to PA	Sixteen item instrument developed by Allison et al. (1999). Eight items reflected internal barriers such as lack of energy and feeling stressed. Eight items reflected external barriers such as time constraints and cost. Responses were on a 5-point scale from 1 (<i>Not at all</i>) to 5 (<i>A great deal</i>).	Internal barriers ($\alpha = 0.71$). External barriers ($\alpha = 0.65$).
Enjoyment of PA	Eighteen item PACES (Physical Activity Enjoyment Scale) developed and validated by Kendzierski and DeCarlo (1991). Each item was presented as a semantic differential (e.g., "I enjoy it" to "I hate it"). Respondents circled the number (on a scale of 1 to 5) corresponding to the degree of affinity that she feels for one of the anchors.	Enjoyment ($\alpha = 0.91$).

Notes: PA = physical activity. ^aTests of internal consistency are presented as Cronbach's alpha values. Psychometric properties were assessed in the study sample.

Data analysis

Variables were screened for violations of statistical assumptions (e.g., normality, linearity). Participation in vigorous activity was dichotomized (“some” *vs.* “none”) owing to the high number of respondents who reported no vigorous physical activity.

To account for the non-independence of observations, the effect of the intervention on potential psychosocial mediators (i.e., self-efficacy, social support, perceived barriers, and enjoyment) and dependent variables (i.e., vigorous activity and cardiovascular fitness) was assessed using multi-level random coefficient modeling (HLM, version 6.0, Scientific Software International, Lincolnwood, IL) (Bryk & Raudenbush, 1992; Raudenbush, Bryk, Cheong, & Congdon, 2000). This procedure is useful for testing changes in outcomes measured on repeated occasions (Singer & Willett, 2003). The present study used a two-level random-slope and random-intercept regression model. The level-one equations estimated the mean value (i.e., intercept, β_{00}) and rate of change (i.e., slope, β_{01}) in the mediators and dependent variables across all time points within each person. These equations used the following form: $\pi_0 = \beta_{00} + \beta_{01}(\text{time}) + r_0$. The level-two equations tested group assignment (i.e., intervention *vs.* comparison) as a predictor of between-person variability in the intercepts and slopes for the mediators and dependent variables. These equations used the following form: $\beta_{00} = \gamma_{000} + \gamma_{001}(\text{group}) + \mu_{00}$ and $\beta_{01} = \gamma_{010} + \gamma_{011}(\text{group}) + \mu_{01}$. The extent to which the intervention influenced the binary dependent variable, vigorous activity (“some” *vs.* “none”), was tested using a non-linear multi-level random modeling approach called the Hierarchical Generalized Linear Model (HGLM) function (Raudenbush et al., 2000). Level-two predictors of slope but not intercept were entered in this model. Mediation was tested according to the recommendations of Baron and Kenny (1986). All multilevel models controlled for ethnicity (i.e., Caucasian *vs.* non-Caucasian). We also controlled for cohort (i.e., year 1, year 2, or year 3) to account for the influence of unmeasured variables. A more conservative approach of using robust standard errors was taken for all analyses owing to the fact that many of the outcome variables were moderately skewed.

Data were first analyzed using an intention-to-treat model, which included all participants regardless of their level of exposure to the intervention or whether they completed the study. Due to difficulties in collecting data from participants who had either changed schools or moved away during the study, there were some missing data at Time 2 and 3. A subsequent analysis used a per-protocol model, which only included participants who successfully completed the study and therefore, provided data at all three assessment periods.

The extent to which within-person changes in psychosocial variables explained changes in outcomes was tested using multiple regression analyses for cardiovascular fitness and logistic regression for vigorous activity. The residuals for the regression of Time 3 on Time 1 for all psychosocial variables were entered as the independent variables. These models statistically controlled for Time 1

measurements of vigorous physical activity and fitness so that the dependent variables, Time 3 measurements of vigorous activity and fitness, could be interpreted as the residual changes in those constructs. All analyses controlled for ethnicity, percent body fat, and cohort. Missing data were treated with listwise deletion. A per-protocol analytic approach was taken because it was not possible to calculate residual scores for participants who were missing data at Time 3.

Results

Descriptive statistics

Participants ranged in age from 14–17 ($M = 15.10$, $SD = 0.81$), reported good health (single item, range 1–5; $M = 2.41$, $SD = 0.82$), and had a mean Grade Point Average (GPA) of 3.12 ($SD = 0.81$). Participants' average height was 1.62 m ($SD = 0.06$) and average weight was 60.68 kg ($SD = 11.86$). The mean BMI for the sample was 23.15 ($SD = 4.54$). Participants were diverse, with 58% non-Hispanic White, 20% Hispanic, 14% Asian, 4% African-American, and 4% "other." The intervention group included a marginally greater proportion of non-Hispanic Whites than the comparison group (65% *vs.* 49%; $\chi^2(df = 1) = 3.48$, $p = 0.062$). There were no significant differences between the intervention and comparison groups at baseline on any of the psychosocial or physical activity variables assessed. Overall, participants who completed the study were younger ($t(144) = 2.10$, $p = 0.038$), reported better overall health ($t(144) = 2.16$, $p = 0.032$), and had a higher GPA ($t(135) = 4.35$, $p < 0.001$) at baseline than participants who did not complete the study. Table II shows the means and SDs for the psychosocial variables, physical activity, and cardiovascular fitness measured at Time 1, Time 2, and Time 3.

Effect of the intervention on psychosocial variables, physical activity, and fitness

An intention-to-treat analysis showed that intervention participants experienced larger improvements in vigorous physical activity ($p = 0.001$) and cardiovascular fitness ($p = 0.008$) than members of the comparison group. The intervention also had a significant effect on internal ($p = 0.025$) and external barriers ($p = 0.006$) to physical activity, but the effect was not in the hypothesized direction (Table II). Within the intervention group, scores for perceived internal and external barriers significantly increased across the two semesters ($p < 0.05$). However, accounting for the effects of internal and external barriers in the model did not significantly reduce the effects of the intervention on vigorous activity and fitness. Thus, changes in perceived barriers to physical activity did not mediate the impact of the intervention on these outcomes. The intervention had no effect on internal self-efficacy, external self-efficacy, family support, friend support, or enjoyment, thus this making further tests of mediation unwarranted. Results were similar when a per-protocol analysis was performed.

Table II. Descriptive statistics for psychosocial variables, physical activity, and fitness ($n = 146$ who started the study).

Intervention ($n = 79$)										Comparison ($n = 67$)					
Time 1			Time 2			Time 3				Time 1			Time 2		
n	M	(SD)	n	M	(SD)	n	M	(SD)		n	M	(SD)	n	M	(SD)
Global self-eff.	79	3.87 (1.06)	74	3.86 (0.93)	72	3.92 (0.90)	67	3.58 (1.18)	59	3.58 (1.07)	58	3.74 (1.09)	58	3.58 (1.07)	58
Int. self-eff.	79	3.00 (0.72)	75	2.67 (0.53)	72	2.74 (0.57)	67	2.89 (0.65)	60	2.82 (0.65)	58	2.66 (0.69)	58	2.82 (0.65)	58
Ext. self-eff.	77	3.17 (0.58)	74	2.80 (0.48)	72	2.87 (0.63)	66	3.08 (0.79)	60	2.96 (0.68)	60	2.96 (0.72)	60	2.96 (0.68)	60
Int. barriers	78	2.63 (0.77)	75	2.92 (0.62)	72	3.02 (0.75)	66	2.58 (0.80)	58	2.54 (0.78)	60	2.65 (0.86)	60	2.65 (0.86)	60
Ext. barriers	79	2.28 (0.62)	74	2.54 (0.55)	71	2.68 (0.65)	66	2.33 (0.68)	60	2.43 (0.69)	59	2.38 (0.72)	59	2.43 (0.69)	59
Family support	78	1.69 (0.67)	75	1.59 (0.67)	71	1.73 (0.77)	66	1.79 (0.73)	61	1.74 (0.77)	60	1.69 (0.81)	60	1.74 (0.77)	60
Friend support	79	1.84 (0.68)	74	1.71 (0.71)	70	1.79 (0.81)	65	1.77 (0.65)	61	1.69 (0.78)	60	1.82 (0.75)	60	1.69 (0.78)	60
Enjoyment	78	3.37 (0.67)	73	3.51 (0.67)	72	3.50 (0.78)	64	3.41 (0.61)	58	3.54 (0.65)	59	3.65 (0.53)	59	3.54 (0.65)	59
VO ₂ peak ^a	79	22.89 (5.12)	71	22.60 (4.78)	71	23.85 (4.68)	67	23.95 (4.20)	60	22.34 (4.21)	59	22.91 (3.62)	59	22.34 (4.21)	59
Vigorous (%) ^b	78	55	74	65	72	82	67	43	61	48	60	58	60	58	58

Notes: Non-adjusted means are presented. All models control for ethnicity, and cohort.

^aVO₂ peak in ml min⁻¹ kg.⁻¹

^bPercent of participants reporting at least some vigorous activity.

^cEstimated using HGLM, a non-linear analysis for binary outcomes using the Bernoulli distribution.

^{**} $p < 0.01$.

^{*} $p < 0.05$.

Table III. Changes in psychosocial variables predicting changes in physical activity and fitness ($n = 122$ who completed the study).

	Vigorous activity	VO ₂ peak ^a
	OR	β
Global self-eff.	0.97	0.208*
Internal self-eff.	1.20	0.049
External self-eff.	0.91	-0.056
Family support	1.09	-0.134
Friend support	1.50	-0.062
Enjoyment	0.57	0.195*
External barriers	0.82	0.062
Internal barriers	1.79	0.183 [†]
	Chi-square (df)	Change in R^2 (df)
	2.87 (8)	0.113 [†] (8)

Notes: Changes between Time 1 to Time 3 were examined. All models control for ethnicity, cohort, and the baseline value of the dependent variable.

^aVO₂ peak in ml min⁻¹ kg⁻¹.

* $p < 0.05$.

[†] $p < 0.06$.

Changes in psychosocial variables predicting changes in physical activity and fitness

Using an individual-level longitudinal approach, positive changes in global self-efficacy ($p = 0.022$) and exercise enjoyment ($p = 0.026$) were associated with improvements in cardiovascular fitness after accounting for changes in the other psychosocial variables included in the model (Table III). Increased perceptions of internal barriers to physical activity were marginally related to improvements in cardiovascular fitness ($p = 0.06$). Overall, the psychosocial variables explained 11% of the variance in change in cardiovascular fitness. Changes in vigorous activity, on the other hand were neither related to changes in psychosocial variables nor to changes in cardiovascular fitness.

Discussion

The current longitudinal study determined whether SCT variables accounted for improvements in physical activity and fitness among sedentary adolescent females participating in a school-based intervention. Results showed that the selected psychosocial variables (i.e., self-efficacy, social support, perceived barriers, and enjoyment), did not mediate the effects of the intervention on physical activity and fitness. However, an individual-level longitudinal approach demonstrated that positive changes in global self-efficacy and exercise enjoyment were associated with improvements in cardiovascular fitness. Although these findings fail to provide support for the mediating role of SCT variables in a school-based intervention, they offer support for the proposition that individual level improvements in self-efficacy and enjoyment are related to increased cardiovascular fitness among sedentary adolescent females.

Despite its positive impact on physical activity and cardiovascular fitness outcomes, the intervention did not, at the group level, influence any of the targeted psychosocial variables in the hypothesized direction. Consistent with prior research that has failed to detect effects of supervised physical activity interventions on proposed mediators (Baranowski et al., 1998; Neumark-Sztainer et al., 2003a), group means for the psychosocial variables showed only minimal changes from baseline to the end of the second semester. Interestingly, effects in the opposite direction were observed for perceived barriers to physical activity. Perceptions of internal and external barriers to physical activity steadily increased across the two semesters within the intervention group. Although it seems somewhat counterintuitive to think that individuals would perceive greater barriers to physical activity as they become more active, similar results have been reported (Allison et al., 1999). By way of explanation, it has been proposed that, "individuals who engaged in higher levels of physical activity are more aware of obstacles to further activity" (p. 614, Allison et al., 1999). Thus, the intervention participants may have reported greater barriers to activity for the simple reason that they in fact encountered those barriers with greater frequency during the intervention than they did before they increased their attempts to be physically active.

Beyond its effect on perceived barriers, the intervention did not influence any of the other psychosocial variables that were measured. Consistent with prior research that has failed to detect effects of physical activity interventions on proposed mediators (Baranowski et al., 1998), most of the psychosocial variables showed only minimal changes from baseline to 9 months. Findings from LEAP (Dishman et al., 2004) that self-efficacy acted as a partial mediator of change in physical activity within the context of a school-based intervention were not replicated in the current study. In fact, internal and external self-efficacy for physical activity declined slightly (though not significantly) over the course of the intervention. The discrepant findings may have to do with the differences in the studies' target populations. Unlike LEAP, the current intervention targeted sedentary, unfit adolescents. As compared to normally active and fit adolescent females, levels of self-efficacy for physical activity among sedentary and unfit individuals may respond differently to a school-based physical activity intervention. Special considerations may be necessary in designing and measuring the effects of interventions for this population.

Another explanation for the lack of significant effect of the intervention on the proposed mediators is that the psychosocial intervention components did not have the intended impact on psychosocial variables. The intervention included a number of psychosocial components that were designed to positively impact self-efficacy, social support, perceived barriers, and exercise enjoyment. For example, self-efficacy was targeted through the confidence building class activities. Teamwork and positive communication were encouraged to build social support for physical activity. The weekly discussions addressed strategies for overcoming barriers to being physically active. Interesting and fun in-class activities such as aerobics and yoga were provided in order to increase

participants' enjoyment for physical activity. However, it is possible that these intervention components were not received in the manner that was intended. The activities could have had a weak impact on the selected psychosocial variables or influenced different psychosocial variables altogether (e.g., knowledge, attitudes). The failure of physical activity interventions to significantly impact SCT mediators has been reported in previous studies (e.g., Hallam & Petosa, 1998; Nichols et al., 2000). Future research should consider how to effectively design intervention components that result in the desired impact on theoretical psychosocial mediators.

Limitations in the explanatory power of the underlying theoretical approach may offer a final explanation for the failure of the psychosocial variables to mediate the effects of the intervention on physical activity and fitness. Applying a theoretical framework other than or in addition to SCT [e.g., Transtheoretical Model (TTM), Theory of Planned Behavior (TPB), Self-Determination Theory (SDT)] might better illuminate the behavior change process for this population. Although SCT has received considerable support for its role in explaining physical activity among adolescents and adults (Biddle et al., 2005; Dishman et al., 2004; Lewis et al., 2002), a different theoretical perspective may be more appropriate for describing behavior change in sedentary adolescent females.

Although a significant effect of the intervention on psychosocial variables was not found, an individual-level longitudinal approach showed that individual improvements in cardiovascular fitness were related to increased levels of global self-efficacy and exercise enjoyment. The existence of longitudinal relationships in the absence of an overall intervention effect lends itself to a few interpretations. First, sedentary adolescent females may vary considerably in terms of their psychosocial response to a supervised physical activity intervention. Although the present intervention was designed to foster the development of psychosocial resources by generating feelings of confidence, social support, and exercise enjoyment; individual differences in response to the intervention may have obscured any expected group effect. The finding that individual gains in self-efficacy and enjoyment were linked to enhanced fitness may indicate that, improvements in these psychosocial variables increased engagement in fitness-building activities regardless of group membership.

Another possible interpretation is that changes in fitness could have prompted changes in psychosocial variables. That is, variations in genetically determined physiological responsiveness to training may have contributed to the observed individual differences in fitness change, and those individuals experiencing greater fitness changes may, in turn, have developed an increased sense of self-efficacy and enjoyment of physical activity. This explanation would be consistent with the aspect of SCT that posits that changes in behavior may bring about alterations in perceptions. Future research should seek to sort out the causal direction of the relationship between psychosocial variables and cardiovascular fitness.

Methodological and/or theoretical explanations could account for the closer association of psychosocial variables to cardiovascular fitness as compared to vigorous activity. First, self-reported physical activity can be vulnerable to numerous biases such as memory distortions and social desirability (Adams et al., 2005), whereas VO_2 peak assessed via cycle ergometer provides a highly accurate measure of physical fitness in adolescents (Cooper et al., 1984). These factors may explain why changes in vigorous physical activity were unrelated to changes in cardiovascular fitness in the current study. The observed relationship of self-efficacy and enjoyment to cardiovascular fitness might have resulted from the more precise methodology of the cycle ergometer. Alternatively, there is some evidence to suggest that among adolescent females, changes in psychosocial variables are more closely tied to physiological outcomes such as physical fitness than behavioral to parameters. For example, Dunton, Schneider, Graham and Cooper (2006) found that physical self-perceptions were more closely associated with cardiovascular fitness and percent body fat than they were with physical activity.

Limitations

This study was limited by its quasi-experimental design and selective attrition patterns. Participants were assigned to the intervention and comparison groups based on the school that they attended instead of through a randomization procedure. However, the selected schools were comparable in terms of demographic and academic characteristics [i.e., academic achievement (API), percent of student qualifying for free lunch], and efforts were made to statistically control for any observed differences (i.e., ethnicity). In terms of attrition, individuals completing the study had more favorable characteristics such as better overall health and higher GPAs than individuals dropping out of the study prior to the last assessment. However, a more conservative statistical approach that imputed baseline values for subsequent missing values at semester one and semester two produced similar results.

Conclusion

Overall, the present study highlights the relationships of self-efficacy and exercise enjoyment to improved fitness levels among sedentary adolescent females. Future research should seek to disentangle the causal direction of these associations in the context of a supervised physical activity intervention. If changes in self-efficacy and enjoyment precede improvements in cardiovascular fitness, interventions targeting sedentary adolescent females should seek to include activities that foster feelings of confidence and stimulate positive affect during physical activity. On the other hand, if the reverse is true, and positive changes in cardiovascular fitness are found to influence psychosocial variables, then supervised physical activity interventions should strive to improve fitness

so that resulting changes in psychosocial variables can promote unsupervised activity outside of the intervention setting.

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