Self-Efficacy Moderates the Relation Between Declines in Physical Activity and Perceived Social Support in High School Girls

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Objective To test whether self-efficacy for overcoming barriers to physical activity has direct, indirect (i.e., mediated), or moderating relations with naturally occurring change in perceived social support and declines in physical activity during high school. **Methods** Latent growth modeling was used with measures completed in the 8th, 9th, and 12th grades by a cohort of 195 Black and White girls. **Results** Self-efficacy was stable and moderated the relation between changes in physical activity and perceived social support. Girls who maintained a perception of strong social support had less of a decline in physical activity if they also had high self-efficacy. However, girls having high self-efficacy had a greater decline in physical activity if they perceived declines in social support. **Conclusions** Randomized controlled trials of physical activity interventions based on social cognitive theory should consider that the influence of girls' perceptions of social support on their physical activity may differ according to their efficacy beliefs about barriers to physical activity.

Key words adolescents; growth curve analysis; health behavior; race/ethnicity.

Insufficient physical activity among adolescent girls is a public health concern in the United States, especially as it relates to increasing incidence of obesity and type 2 diabetes (Ogden, Carroll, & Flegal, 2003; Wang & Dietz, 2002) and the risk of sedentary adult behavior (Campbell et al., 2001). Girls have twice the rate of decline in physical activity during high school compared to boys. Nearly two of three girls and three of four boys in the United States participate in sufficient vigorous physical activity when they are in the 9th grade, but by the 12th grade, only 46% of girls are sufficiently active compared to 64% of boys (Grunbaum et al., 2004). Population estimates indicate that participation in leisure time physical activity among girls declines by about 45% between ages 12 and 17 (Caspersen, Pereira, & Curran, 2000) and by 80% between ages 9 and 17 (Kimm et al., 2002). Mediators and moderators of physical activity that can guide successful interventions to increase physical activity, or lessen its decline, are poorly understood among adolescent girls (Luban, Foster, & Biddle, in press). Mediators are variables in a causal sequence that transmit the relation or effect of an independent variable on a dependent variable. Moderators are variables not in a causal sequence but that modify the relation or effect between an independent variable and a dependent variable (MacKinnon, Fairchild, & Fritz, 2007).

Social cognitive variables (i.e., beliefs that are formed by social learning and reinforcement history) are putative influences on self-initiated change in health behaviors such as physical activity (Bandura, 2004). They may be especially important during early adolescence, when physical activity increasingly becomes a leisure choice. Although efficacy beliefs about physical skills or behavior change skills (Bandura, 1997) might explain variation in physical activity, self-regulatory efficacy about overcoming barriers has been prominent in applications of social cognitive theory to health behaviors (Bandura, 2004). Self-regulatory efficacy beliefs about the ease or difficulty of overcoming personal (e.g., sedentary choices, feelings of fatigue) and environmental (e.g., obstacles, lack of time or opportunity, and securing social support) barriers to participating in

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physical activity have been related to physical activity levels among adolescent girls, regardless of outcome expectancy values (Dishman et al., 2004; Motl et al., 2002; Neumark-Sztainer, Story, Hannan, Tharp, & Rex, 2003). They also accounted for part of the cross-sectional relation between social support and physical activity in a large sample of girls in the 12th grade (Motl, Dishman, Saunders, Dowda, & Pate, 2007). However, those studies did not examine whether self-efficacy predicts change in physical activity across the high school years, a necessary first step toward elucidating its causal influence on declines in physical activity.

Recent reports of longitudinal, cohort studies suggest that declines in physical activity during the period from late middle school through late high school are inversely associated with self-efficacy for overcoming barriers to physical activity and also with perceived support from family (Dowda, Dishman, Pfeiffer, & Pate, 2007) and friends (Duncan, Duncan, Strycker, & Chaumeton, 2007). These studies did not examine whether the relations were direct or also indirect, as posited by social cognitive theory. Efficacy beliefs about overcoming barriers can have indirect influences on behavior by fostering the search for social support (Bandura, 1997) or by influencing how people view sociocultural environments that facilitate or impede physical activity (Bandura, 2004). Social cognitive theory recognizes that social environments ''provide continued personalized guidance, natural incentives, and social supports for desired changes'' (Bandura, 2004, p. 150). Thus, part of the hypothesized effect of self-efficacy on physical activity might be mediated (Holmbeck, 1997) by perceptions of social support. In this instance, girls who have an increase in self-efficacy for overcoming barriers to physical activity would be more likely to secure social support (e.g., be more confident in asking parents or friends to be active with them), which might be the direct influence on physical activity. Social cognitive theory also implies that self-efficacy could moderate the relation between changes in perceived social support and physical activity (Bandura, 2004). In this instance, girls who maintain high self-efficacy for overcoming barriers to physical activity would be more likely to sustain their physical activity despite perceptions of decreasing social support (e.g., reduced engagement with parents or changing social networks) during adolescence.

Here, we report a longitudinal observational study of these hypothesized relations among naturally occurring changes in physical activity, self-efficacy for overcoming barriers to physical activity, and perceived social support of physical activity during high school among Black and White girls. Past studies did not examine mechanisms by which social support might influence physical activity (Duncan, Duncan, & Strycker, 2005). Based on theory (Cutrona & Russell, 1987; Weiss, 1974) and previous studies (Motl et al. 2007; Motl, Dishman, Saunders, Dowda, & Pate, 2004; Saunders, Motl, Dowda, Dishman, & Pate, 2004), we assessed three correlated features of social support: guidance (advice or information), opportunity for nurturance (the sense that others rely upon one for their well-being), and reassurance of worth (recognition of one's competence, skills, and value by others). These factors can be measured similarly in Black and White adolescent girls (Motl et al., 2004), and they collectively are related to physical activity independently of race and social norms (Saunders et al., 2004).

The purpose of this longitudinal study was to provide tests of direct, indirect (i.e., mediated), and moderating relations of self-efficacy with change in physical activity and perceived social support, consistent with social cognitive theory (Bandura, 2004) and contemporary use of structural equation modeling to test mediation and moderation of longitudinal change (MacKinnon et al., 2007). The main hypotheses were (a) change in self-efficacy and perceived social support would each be related to change in physical activity; (b) the relation between self-efficacy and change in physical activity would be indirect, mediated by perceived social support; and (c) self-efficacy would not be directly or indirectly related to change in physical activity, but rather it would moderate the relation between change in perceived social support and change in physical activity.

Method

Participants were 195 girls from 12 public high schools in South Carolina that were in the control arm of the Lifestyle Education for Activity Program (LEAP) trial, a group-randomized intervention designed to increase physical activity and fitness in adolescent Black and White girls in South Carolina (Pate et al., 2005). Although the primary aim of the LEAP study was to increase moderate to vigorous physical activity between the eighth and ninth grades, a secondary aim was to examine social cognitive correlates of naturally occurring change in physical activity during high school.

Hence, 3 years after the LEAP intervention ended, 200 consenting members (51% Black, 47% White) of the control cohort ($n = 741$) were assessed again at the end of their 12th-grade academic year. Analyses were conducted on Black ($n = 101$) and White ($n = 94$) girls. Loss to follow-up resulted mainly from failure to complete high school (45%), transferring out of the schools (10%), or nonattendance on testing days (5%). The retested cohort did not differ at baseline ($p > .05$; $M \pm SD$) from other LEAP eighth graders in the control schools who were subsequently lost to follow-up, or from the intervention cohort at 8th, 9th, and 12th grades, respectively, in age (13.6 ± 0.6, 14.6 ± 0.6, and 17.7 ± 0.6 years), fitness (physical working capacity (PWC)-170) (10.2 ± 3.0, 10.6 ± 3.2, and $11.2 \pm 3.6\,kg^{-m}$/min/kg), body mass index (23.0 ± 5.3, 23.8 ± 5.4, and $24.0 \pm 6.0\,kg/m^2$), physical activity (63.0 ± 10.3, 63.2 ± 10.0, and 61.5 ± 11.4 metabolic equivalents (METs)/3 days), or in participation in organized sports or enrollment in physical education classes. Compared at baseline to other LEAP eighth graders in the control schools who were subsequently lost to follow-up, the participants had higher ($p < .05$) perceived social support (3.79 ± 0.66 vs. 3.08 ± 0.43, $\omega^2 = .13$), but similar ($p > .05$) self-efficacy (3.82 ± 0.74 vs. 3.76 ± 0.72, $\omega^2 = .00$).

Measures

Physical activity was assessed using the 3-Day Physical Activity Recall (3DPAR) (Pate, Ross, Dowda, Trost, & Sirard, 2003), which required participants to recall physical activity behavior from three previous days of the week (first Tuesday, then Monday, then Sunday). Those days were selected to capture physical activity on one weekend day and two weekdays. A list of 55 commonly performed activities, grouped into broad categories (i.e., eating, work, after-school/spare time/hobbies, transportation, sleeping/bathing, school, and physical activities and sports) to improve activity recall was administered as a questionnaire in classroom settings using standardized instructions by trained testing staff. To improve the accuracy of physical activity recall, the 3 days were segmented into thirty-four, 30-min time blocks, beginning 7:00 a.m and continuing through to 12:00 a.m. Based on the type of activity and level of intensity, each 30-min block was assigned a MET value (i.e., physical activity level expressed as multiples of basal metabolic rate). The MET values were summed over the 3 days. The validity of the 3DPAR as a measure of usual activity has been established based on correlations with an objective measure of physical activity derived from accelerometry (Pate et al., 2003).

The measure of self-efficacy for overcoming barriers contained eight items rated on a 5-point Likert-type scale ranging from 1 (*Disagree a lot*) to 5 (*Agree a lot*). Example items were the following: ‘‘I can be physically active during my free time on most days even if it is very hot or cold outside,’’ and ‘‘I can ask my parent or other adult to do physically active things with me.’’ The measure of self-efficacy has conformed to a single-factor model that was invariant across 1 year between the eighth and ninth grades (Motl et al., 2000) and between Black and White girls from the LEAP study (Dishman et al., 2002).

Social support was measured using a version of the Social Provisions Scale (Cutrona & Russell, 1987) modified for physical activity in adolescent girls (Motl et al., 2004). The items were rated on a 5-point Likert-type scale that ranged between *Disagree a lot* (1) and *Agree a lot* (5). Example items were the following: ‘‘There is a person I can turn to for advice if I have problems with physical activity,’’ ‘‘There are people who depend on me to help them be physically activity.’’ Factorial validity and longitudinal invariance of the modified scale have been demonstrated in separate samples of eighth- and ninth-grade girls (Motl et al., 2004). A factor structure of first-order factors subordinate to a second-order social provisions factor was supported, but the structure and number of factors differed between White and Black girls. Three correlated factors (guidance, nurturance, and reassurance of worth) were common to both groups (Motl et al., 2004). The sum of these factors was related to physical activity among 8th-grade (Saunders et al., 2004) and 12th-grade girls, so it was used as the measure of social support in this study.

Longitudinal Factor Invariance

Prior to hypothesis testing, we used confirmatory factor analysis (CFA) to test the longitudinal factor invariance of the scales to determine whether the social cognitive variables were measured similarly across time. Longitudinal factor invariance is the degree to which those configural and measurement properties are similar across points in time (Hoyle & Smith, 1994), and is necessary for the proper interpretation of change across time in tests of mediation or moderation (Mackinnon et al., 2007). The CFA was performed with full-information maximum likelihood (FIML) estimation using Mplus 5.1 with FIML (Muthén & Muthén, 1998–2008). Missing responses to items on the questionnaires ranged from 0% to 3% and were 1% overall.

The analysis of longitudinal factor invariance of the self-report scales followed standard procedures for testing measurement equivalence/invariance. A single-group, correlated measurement model of three repeated measures was specified with autocorrelations between the repeated first-order factors (and the second-order factor for social support) assessed in the 8th, 9th, and 12th grades. The measurement error terms (item uniquenesses) were allowed to covary because some of the systematic variance unaccounted for by the latent factor should be the same over time. Five sequential nested models that each imposed an additional restraint on model parameters were compared. Model 1 freely estimated all hypothesized parameters and provided the baseline model of structure across the three times. Model 2 added a test of metric invariance by also constraining factor loadings to be equal. Model 3 tested scalar invariance by additionally constraining intercepts of like item's regressions on the latent variable to be equal. Model 4 added a test of equal factor variances/covariances. Model 5 was most restrictive by adding a constraint that items' uniquenesses (i.e., error variances) were equal across time (Bollen, 1989). The comparison of each successive model with the preceding model was based on a chi-square difference test and changes in the values of the comparative fit index (CFI), the non-normed fit index (i.e., the Tucker–Lewis index), the root mean square error of approximation (RMSEA), and the standardized root mean square error (SRMR). Examining differences between two nested models in the CFI and overlap in the RMSEA point estimates and their 90% confidence intervals is superior to interpretations based strictly on χ^2 difference tests (Cheung & Rensvold, 2002). The primary criterion for invariance for each successive model was a decrease of ≤ 0.01 in the CFI (e.g., $CFI_{model\ 2} - CFI_{model\ 1}$), which is a robust standard for testing longitudinal invariance (Cheung & Rensvold, 2002).

Invariant factor structure and loadings (i.e., models 1 and 2 have acceptable fit and do not differ from each other) were viewed as sufficient evidence for measurement invariance (Byrne, 2001). The CFA models were also adjusted for nesting effects of school by using the within-subjects covariance matrix centered on school means and correcting the standard errors of the adjusted parameter estimates for between-school variance using the Huber–White sandwich estimator (Muthén & Muthén, 1998–2008). Results did not differ or were slightly improved after adjustment for school, so unadjusted results are reported.

Latent Growth Modeling

For hypothesis testing, latent growth modeling (LGM) was performed using Mplus 5.1 with FIML (Muthén & Muthén, 1998–2008). LGM applies CFA to variables measured longitudinally (Meredith & Tisak, 1990; Singer & Willett, 2003). It estimates parameters and their standard errors for factors of initial status (i.e., the latent mean at the eighth grade in this study), change (i.e., the slope or trajectory of change from the 8th to the 12th grade), and the variances (i.e., interindividual differences) of initial status and change. It was used as a three-stage process to examine (a) change in physical activity, self-efficacy, and perceived social support cross time; (b) the relation of change in physical activity with initial status and change in self-efficacy and perceived social support; and (c) the comparison of direct, indirect (i.e., mediated by change in perceived social support), and moderating effects of self-efficacy on the relation of changes in perceived social support and physical activity. Race was coded (*Black* = 0, *White* = 1) as an exogenous covariate in each stage of the LGM. Intraclass correlation coefficient (model 1) values were small ($M = 0.02$, range 0.004–0.08), indicating that school accounted for ~2% of the variance in the study variables. Nonetheless, analyses also were adjusted for nesting effects of school by correcting the standard errors of the parameter estimates for between-school variance using the Huber–White estimator (Muthén & Muthén, 1998–2008). Results were generally not different when adjusted for between-school variance, so unadjusted results are reported unless otherwise noted.

The first stage of LGM tested linear change (using regression weights of 0, 1, and 4 for the three time points) modeled as a latent variable. Parameters and their standard errors were estimated for initial status, change, and the variances (i.e., interindividual differences) of initial status and change. Critical *z*-scores (parameter estimate/*SE*) tested the significance of means for initial status and change.

The second stage of LGM separately examined the relations of self-efficacy and perceived social support with physical activity. This model (Fig. 1) included the first stage of LGM, plus the addition of paths (standardized β-coefficients) between the initial status latent variables ($\beta_{3,1}$) and between the change latent variables ($\beta_{4,2}$).

The third stage of LGM simultaneously examined whether self-efficacy had a direct relation with change in physical activity and/or an indirect relation, mediated through change in perceived social support. This model (Fig. 2) included the second stage of LGM for perceived social support, plus the addition of exogenous paths between the initial status latent variable of self-efficacy to initial status ($\beta_{3,5}$) and change ($\beta_{4,5}$) of physical activity and to initial status ($\beta_{1,5}$) and change ($\beta_{2,5}$) of social support.

Moderating effects of self-efficacy were examined using standard LGM procedures (Klein & Moosbrugger, 2000; MacKinnon et al., 2007; Marsh, Wen, & Hau, 2004) for a test of moderation by creating an additional latent variable that represented the interaction of self-efficacy initial status with the latent change factor for perceived social support and then testing whether the interaction latent variable accounted for the relation between change in social support and change in physical activity that was modeled in the second-stage LGM. Finally, the interaction latent variable was added to the third-stage LGM to

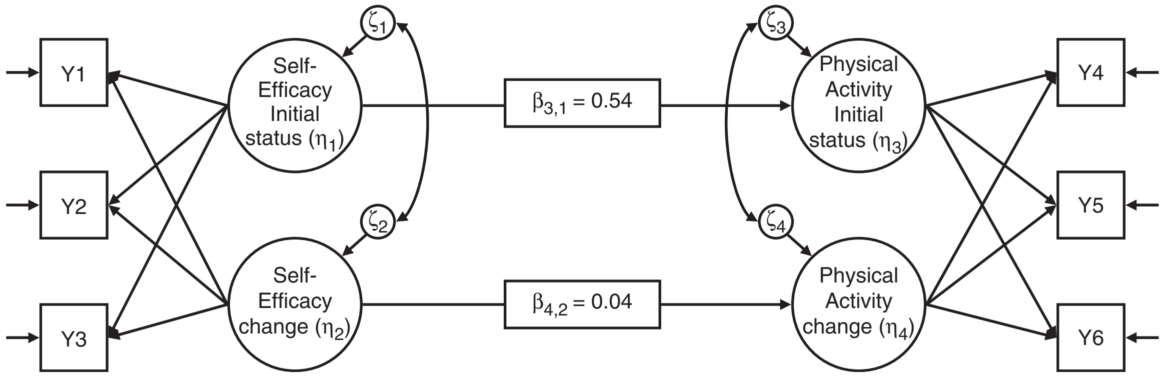

Figure 1. Second-stage latent growth modeling. Path coefficients are presented in completely standardized units (β). Latent variables for initial status and change are denoted as η. Paths from covariates are not shown. Variance estimates for initial status and change are denoted as ζ. Y1-Y3 and Y4-Y6 are observed scores for self-efficacy and physical activity, respectively, in the 8th, 9th, and 12th grades.

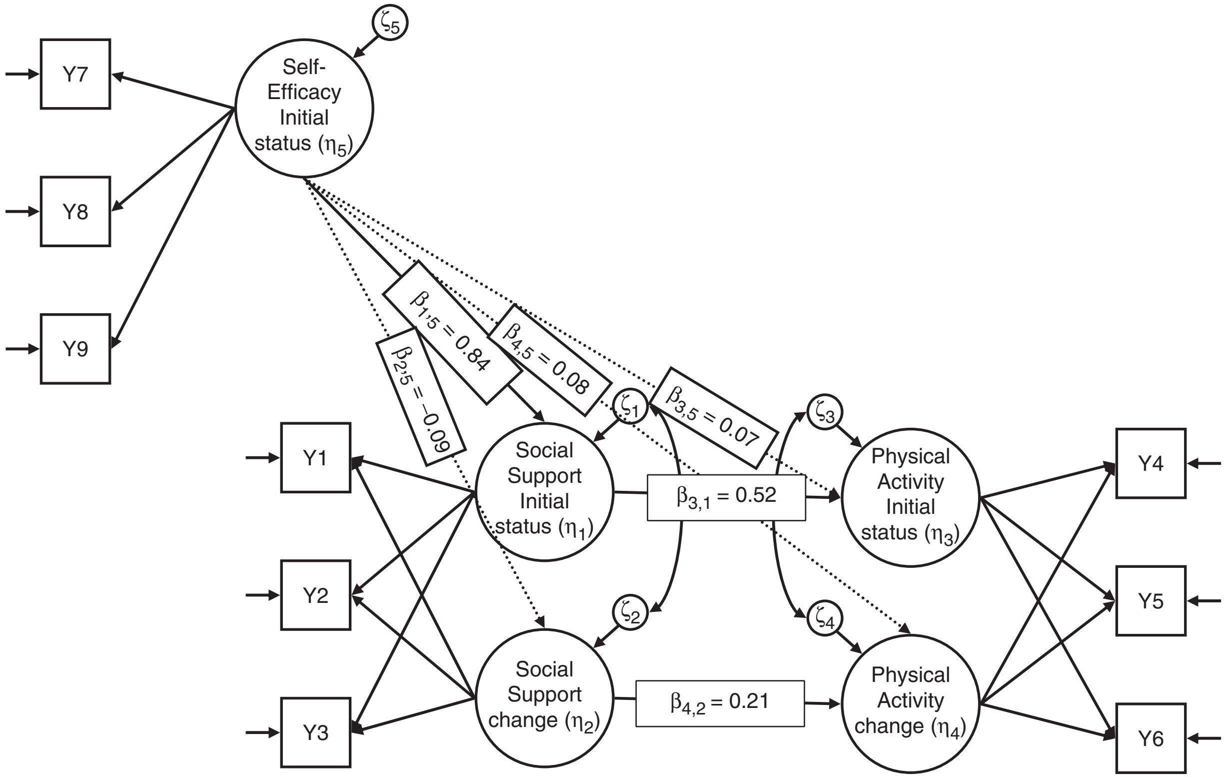

Figure 2. Third-stage latent growth modeling testing whether initial self-efficacy has direct effects on initial level of or change in physical activity or indirect effects, mediated by perceived social support. Symbols are defined in caption for Fig. 1.

determine whether the moderating effect of self-efficacy was independent of its relations with initial status and change of perceived social support (Kraemer, Stice, Kazdin, Offord, & Kupfer, 2001).

Model Fit

The chi-square statistic assessed absolute fit of each model to the data (Bollen, 1989), but the CFI, RMSEA, and the SRMR were also used to examine overall fit (Hu & Bentler, 1999). CFI values ≥ 0.90 and ≥ 0.95 indicate acceptable and good fit, respectively. RMSEA values of $\leq .08$ and $\leq .06$ (and the 90% confidence interval) indicate acceptable and close fit, respectively (Browne & Cudeck, 1993). Concurrent values ≥ 0.96 for CFI and $< .10$ for SRMR provide optimal protection against types I and II error rates, especially in sample sizes ≤ 250 (Hu & Bentler, 1999).

Results

Longitudinal Factor Invariance

Results of the CFA of responses to the questionnaires by the girls according to race are provided in Table I. The measure of self-efficacy conformed to a single-factor structure. The measure of social support conformed to a higher order structure of three first-order factors (guidance, nurturance, and worth) and one second-order factor (social support). Model fit for self-efficacy in the 12th grade was not as good as the other models, but it was acceptable. The overall patterns of fit indices indicated good close fit and supported the factorial validity of the measures in this sample, consistent with prior studies (Dishman et al., 2002; Motl et al., 2000, 2004). Internal consistency reliabilities ranged from .78 to .84 for self-efficacy and social support measures.

Results of the longitudinal invariance analysis for self-efficacy (Table II) indicated that there was acceptable fit of the baseline model of factor structure and that factor loadings, item intercepts, factor variance, and item uniquenesses were invariant (i.e., the successive fit of models 1–5 did not differ) across grades for self-efficacy. For social support, the baseline structure model and the successive model testing equal factor loadings had acceptable fit and did not differ. The model of equal item intercepts was minimally acceptable for social support and marginally different from the model of equal factor loadings. Stability coefficients ($p < .01$) between 8th and 9th, 9th and 12th, and 8th and 12th time periods for scores derived by the CFA were, respectively, as follows: self-efficacy (.66, .60, and .53) and perceived social support (.90, .79, and .70).

Physical Activity: First-Stage LGM

There was a linear decline in physical activity among White girls but not among Black girls. The model provided a good close fit to the physical activity data [$\chi^2 = 0.27$, $df = 1$, $p = .87$, RMSEA = .00 (.00–.10), SRMR = .003, CFI = 1.00]. Parameter estimates of latent means were statistically significant ($p < .01$) for initial status (63.59) and change (−0.53) and for the variance estimates of initial status (31.2) and change (6.05). Change was not related

Table I. Fit Indices and Internal Consistency Reliabilities (Cronbach α), for the Social–Cognitive Measures Assessed in the 8th, 9th, and 12th grades in Black and White girls ($N = 195$)

Measure	χ^2 (*df*)	*p*-value	RMSEA (90% CI)	SRMR	CFI	TLI	Cronbach α
Self-efficacy							
8th grade	29.6 (20)	.08	.050 (0.000–0.085)	.040	0.971	.960	.79
9th grade	38.1 (20)	.01	.068 (0.034–0.101)	.046	0.955	.937	.82
12th grade	48.4 (20)	.001	.085 (0.055–0.116)	.046	0.928	.900	.80
Perceived social support							
8th grade	64.1 (41)	.012	.054 (0.026–0.078)	.050	0.958	.933	.78
9th grade	63.8 (41)	.012	.054 (0.026–0.078)	.050	0.964	.943	.82
12th grade	72.6 (41)	.002	.063 (0.038–0.086)	.045	0.963	.940	.84

Note. *df*, degrees-of-freedom; χ^2, chi-square statistic; RMSEA, root mean square error of approximation; CI, confidence interval; CFI, comparative fit index; TLI, Tucker-Lewis index or non-normed fit index.

Table II. Confirmatory factor analysis testing the longitudinal invariance of the social–cognitive measures

Model	*df*	χ^2	χ^2_{diff} (*p*-value)	RMSEA (90% CI)	SRMR	CFI	TLI
Self-efficacy							
Model 1 (structure)	225	318.7		.046 (0.034–0.057)	.056	0.939	.925
Model 2 (loadings)	239	327.1	8.4 (>.10)	.043 (0.031–0.055)	.061	0.942	.933
Model 3 (intercepts)	255	351.8	24.7 (>.10)	.044 (0.032–0.055)	.064	0.937	.931
Model 4 (factor var)	257	354.5	3.3 (>.10)	.044 (0.032–0.055)	.068	0.936	.931
Model 5 (errors)	273	373.4	18.9 (>.10)	.043 (0.032–0.054)	.079	0.934	.934
Social support							
Model 1 (structure)	490	770.5		.054 (0.047–0.061)	.085	0.900	.870
Model 2 (loadings)	509	743.1	27.4 (>.10)	.049 (0.041–0.056)	.072	0.908	.886
Model 3 (intercepts)	533	790.9	47.8 (<.05)	.050 (0.042–0.057)	.077	0.898	.880
Model 4 (factor var/cov)	538	860.9	70.0 (<.01)	.055 (0.048–0.062)	.082	0.872	.851
Model 5 (errors)	562	937.3	76.4 (<.01)	.059 (0.052–0.068)	.095	0.852	.834

Note. *df*, degrees-of-freedom; χ^2, chi-square statistic; RMSEA, root mean square error of approximation; CI, confidence interval; SRMR, standardized root mean square error; CFI, comparative fit index; TLI, Tucker-Lewis index or non-normed fit index; χ^2_{diff}, chi-square difference test.

to initial status. Addition of race as a covariate yielded a similarly good fit [$\chi^2 = 0.26$, $df = 2$, $p = .88$, RMSEA = .00 (.00–.07), SRMR = .01, CFI = 1.0], and indicated that the decline in physical activity was related to race. A nested model testing the equality of initial status and change in physical activity (MET-hour per week) between the groups indicated that the White girls had higher initial physical activity (65.7 $SE = 0.875$ vs. 61.7 $SE = 0.872$, χ^2 diff = 10.7, $df = 1$, $p < .01$) and a greater decline (-1.16 $SE = 0.326$ vs. 0.03 $SE = 0.354$, χ^2 diff = 6.2, $df = 1$, $p < .01$) than Black girls.

Self-Efficacy: First-Stage LGM

There was no change in self-efficacy across time. The model had a good close fit to the data [$\chi^2 = 0.05$, $df = 1$, $p = .83$, RMSEA = .00 (0.00–.11), SRMR = .003, CFI = 1.0]. Parameter estimates of the latent mean (3.82) and its variance (0.32) were statistically significant ($p < .01$), but the change factor and its variance were not significant. Addition of race as a covariate yielded a similarly good fit [$\chi^2 = 1.05$, $df = 2$, $p = .88$, RMSEA = .00 (.00–.11), SRMR = .02, CFI = 1.0], and indicated that White girls had higher initial status ($p < .01$).

Social Support: First-Stage LGM

There was a linear decline in social support scores ($p < .01$). The model provided a good fit to the data [$\chi^2 = 3.16$, $df = 1$, $p = .08$, RMSEA = .10 (.00–.24), SRMR = .031, CFI = 0.970]. Parameter estimates of latent means were statistically significant ($p < .01$) for initial status (3.82) and change (-0.033) and for the variance estimates of initial status and change. Change was inversely related to initial status ($r = -.22$, $p < .05$), indicating that higher initial scores were associated with less decline. Addition of race as a covariate yielded a similarly good fit [$\chi^2 = 3.30$, $df = 2$, $p = .19$, RMSEA = .058 (.00–.165), SRMR = .02, CFI = 0.98), and indicated that neither initial status or change was related to race.

Physical Activity and Social Cognitive Variables: Second-Stage LGM

A model specifying direct and indirect effects of initial status of self-efficacy on initial status and change for physical activity, and a model specifying direct effects of initial status and change factors for perceived social support on initial status and change factors for physical activity were tested.

Self-Efficacy

The model provided a good close fit to the data [$\chi^2 = 14.0$, $df = 12$, $p = .30$, RMSEA = .029 (.00–0.082), SRMR = .042, CFI = 0.991]. The initial status factor for self-efficacy was significantly ($p < .01$) related to the initial status factor for physical activity ($\beta_{3,1} = .60$, $SE = 0.123$) but was unrelated ($p > .10$) to the physical activity change factor ($\beta_{4,2} = -.04$, $SE = 0.116$). Addition of race as a covariate yielded a model that also had good fit [$\chi^2 = 16.1$, $df = 15$, $p = .378$, RMSEA = .019 (.00–.072), SRMR = .037, CFI = 0.996]. Regardless of race, initially higher levels of self-efficacy were associated with initially higher levels of physical activity ($\beta_{3,1} = .54$, $SE = 0.129$) but not with change in physical activity ($\beta_{4,2} = .04$, $SE = 0.120$) (Fig. 1).

Social Support

The model provided a good close fit to the data [$\chi^2 = 10.0$, $df = 9$, $p = .35$, RMSEA = .024 (.000–.086), SRMR = .045, CFI = 0.997]. There was a statistically significant ($p < .01$) and positive direct effect from the social support initial status factor to the physical activity initial status factor ($\beta_{3,1} = .62$, $SE = 0.101$). There was a positive effect from the social support change factor to the physical activity change factor ($\beta_{4,2} = .20$, $SE = 0.093$, $p < .05$), $SE = 0.108$ after adjustment for school. Addition of race as a covariate yielded a model that also had a good fit [$\chi^2 = 14.4$, $df = 12$, $p = .27$, RMSEA = .032 (.00–.083), SRMR = .057, CFI = 0.992]. Regardless of race, initially higher levels of social support were associated with initially higher levels of physical activity ($\beta_{3,1} = .60$, $SE = 0.102$), and change in social support was related to change in physical activity ($\beta_{4,2} = .23$, $SE = 0.132$).

Direct, Indirect, and Moderator Effects of Self-Efficacy: Third-Stage LGM

The third-stage LGM simultaneously examined whether initial self-efficacy had a direct relation with initial status and change in physical activity or an indirect relation, mediated through initial status and change in perceived social support. This model (Fig. 2) was adjusted for race and included the second stage of LGM for perceived social support, plus the addition of paths between the initial status latent variable of self-efficacy to initial status ($\beta_{3,5}$) and change ($\beta_{4,5}$) of physical activity and to initial status ($\beta_{1,5}$) and change ($\beta_{2,5}$) of social support.

Direct and Indirect Effects

The model provided a good fit to the data [$\chi^2 = 50.87$, $df = 31$, $p = .014$, RMSEA = .057 (.026 – .085), SRMR = .044, CFI = 0.967]. The endogenous path coefficients between initial status of social support and initial status of physical activity ($\beta_{3,1} = .52$, $SE = 0.227$) and between change in social support and change in physical activity ($\beta_{4,2} = .21$, $SE = 0.091$) were statistically significant ($p < .05$). Initial status of self-efficacy was no longer directly related to physical activity initial status ($\beta_{3,5} = .07$, $SE = 0.246$) and was unrelated to physical activity change ($\beta_{4,5} = .08$, $SE = 0.107$) and change in social support ($\beta_{2,5} = -.09$, $SE = 0.097$). However, the exogenous path between initial status of self-efficacy to initial status of social support ($\beta_{1,5} = .84$, $SE = 0.058$) and the resulting indirect effect of initial self-efficacy on initial status of physical activity ($\beta = .44$, $SE = 0.146$) were each significant ($p < .01$). The model accounted for 46% of the variance in initial status of physical activity and 10% of the variance in physical activity change. Residual variances of the initial status and change factors were statistically significant ($p < .05$). Results were independent of race. However, adjustment for school increased the standard error of path coefficient ($\beta_{4,2} = .21$, $SE = 0.121$, $p = .08$) between the change factors of social support and physical activity, indicating that part of their relation was explained by otherwise unaccounted variation in scores between schools.

Moderator Effects

The latent interaction of initial self-efficacy with change in social support was significantly related to change in physical activity ($p < .05$), independently of race. Thus, the relation between perceived change in social support differed according to whether girls had high or low self-efficacy. Figure 3 illustrates the moderating effect of self-efficacy. Girls who had high initial levels of self-efficacy and smaller decreases in perceived social support had the lowest decline in physical activity. However, girls with initial high self-efficacy had a greater decline in physical activity if they perceived greater declines in social support. The interaction remained significant ($p < .05$) when it was added to the third-stage LGM, which included the direct and indirect relations of self-efficacy with initial status and change factors for social support and physical activity. Thus, the moderating effect of self-efficacy was independent of relations of self-efficacy with initial status and change of perceived social support. It accounted for the weak relation between change in social support and change in physical activity observed in the second- and third-stage LGM analyses.

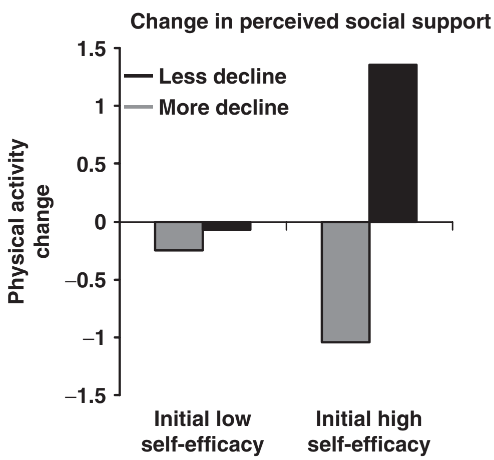

Figure 3. Results of moderator analysis. The effect of the interaction of initial status of self-efficacy with the longitudinal change in perceived social support on declines in physical activity. Scores are standardized. Positive scores indicate less decline in physical activity.

Discussion

A novel aspect of the study was its longitudinal cohort design, which permitted the use of structural equation modeling to test direct, mediated, and moderating effects of self-efficacy on change in physical activity during high school, a time when physical activity declines markedly in girls. Unlike more commonly used cross-sectional designs, which only permit estimates of between-person relations among variables, the longitudinal cohort design permitted estimates of those relations between the girls and also between changes in the variables that occurred within the girls.

Self-efficacy for overcoming barriers to physical activity was stable across the high school years and was not directly or indirectly related to changes in physical activity or perceived social support. Rather, self-efficacy moderated the relation between changes in physical activity and perceived social support. Girls who maintained higher perceptions of social support during high school had less decline in physical activity, but only if they also had high self-efficacy for overcoming barriers to physical activity. High self-efficacy did not mitigate declines in physical activity among girls who reported a decrease in social support. In contrast, girls with high self-efficacy had a greater decline in physical activity if they perceived declines in social support. Physical activity remained low in girls with low self-efficacy, regardless of change in perceived social support.

White girls had higher initial levels and greater decline in physical activity, but they were still more active than Black girls in the 12th grade. White girls also had higher initial level of self-efficacy, but race was not related to change in either self-efficacy or perceived social support. Although the differences in physical activity between the Black and White girls in this cohort were not explainable by self-efficacy or social support, the influences of race and ethnicity on physical activity during adolescence are poorly understood and deserve more study.

Because self-efficacy did not change and was not directly related to change in physical activity, the hypothesized test of mediation could not be conducted. However, the positive bivariate relation between self-efficacy and physical activity observed in the eighth grade was explained by those variables' common relationship with perceived social support. Hence, the cross-sectional relation of self-efficacy with physical activity was indirect, mediated through perceived social support.

Other studies have reported change in girls' self-efficacy across shorter time periods (Duncan et al., 2007; Neumark-Sztainer, 2003), but they did not establish the measurement equivalence/invariance of the questionnaires to ensure that the same construct was being measured at each time. Our results suggest that, in the absence of targeted intervention (e.g., Dishman et al., 2004), girls' self-efficacy about overcoming barriers to physical activity is formed by the eighth grade. If so, physical activity interventions designed to enhance self-efficacy might be especially needed during preadolescence. However, because of the high rate of loss to follow-up common in high school–based longitudinal studies, the generalizability of the findings to the full LEAP cohort is unknown.

The growth modeling results and the longitudinal cohort design satisfy criteria for moderation because the initial status of self-efficacy temporally preceded and was unrelated to the change in perceived social support (Kraemer et al., 2001). Nonetheless, randomized controlled trials are needed for causal tests of effect moderation and mediation. These findings provide initial evidence sufficient to encourage controlled trials to determine whether experimental manipulation of perceived or actual social support can reduce the decline in physical activity among girls during adolescence, especially among girls who initially have high self-efficacy about overcoming barriers to physical activity. Similarly, experimental studies are needed to determine whether manipulations of self-efficacy can alter perceptions about social support of physical activity.

Consistent with social cognitive theory, changes in perceived social support were unrelated to change in physical activity among girls who maintained low self-efficacy. Contrary to social cognitive theory, high self-efficacy did not mitigate declines in physical activity among girls who perceived a reduction in social support. This is explainable because the self-efficacy measure was not restricted to social barriers to physical activity but included personal (e.g., sedentary choices, feelings of fatigue) and environmental (e.g., obstacles, lack of time, or opportunity) barriers in addition to those associated with securing social support for physical activity. Future studies should include objective measures of opportunities for physical activity (e.g., availability of personal or public transportation to physical activity venues and access to safe and pleasant parks). For example, proximity to commercial facilities is related to physical activity participation in 12th-grade girls, independently of their perception of access or their self-efficacy for overcoming barriers (Dowda et al., 2008).

Prior studies of adolescent girls have established that social support from parents (Dowda et al., 2007) and friends (Duncan et al., 2007) is inversely related to declines in physical activity and that peer social networks are related to cross-sectional physical activity levels (Voorhees et al., 2005). Hence, social incentives may be especially strong influences on physical activity or inactivity among girls during high school regardless of high self-efficacy for overcoming other types of barriers to activity. Low self-efficacy for overcoming those barriers appears to limit girls' attempts to be more active or their persistence regardless of changing perceptions of social support. It is also possible that the social provisions scale operated as a proxy measure of social networks or incentives. If so, high self-efficacy would not ensure high physical activity among girls whose friends or family was inactive.

We measured perceived social support and self-reported physical activity, so future research should also examine actual social support in association with self-reported and objectively measured (e.g., by accelerometry) physical activity. However, the 3DPAR was validated for use with girls based on its relation with accelerometer counts, consistent with contemporary standards for validating self-report measures of physical activity in adolescents (Sirard & Pate, 2001). We have observed significant relations of physical activity measured by accelerometry with the self-efficacy measure used here and a different measure of social support in a separate sample of eighth-grade girls (Dishman, Dunn, Sallis, Vandenberg, & Pratt, 2008), so we doubt the results are only the result of using a common method of self-report for all measures.

Although perceived social support appears more related to physical activity among eighth- and ninth-grade girls than are subjective social norms (Saunders et al., 2004), the cultural environment (i.e., sociocultural milieus that differ in shared values, customs, and social practices) might have a stronger relation with physical activity than physical and social environments (Bandura, 1997). This might be particularly the case among some adolescent girls of African American or Hispanic descent for whom the cultural meaning or roles of physical activity might differ or might be modified by features of urban or rural environments (e.g., Wilbur, Chandler, Dancy, Choi, & Plonczynski, 2002). We recommend that future research on social cognitive influences on physical activity include efficacy beliefs specific to overcoming social barriers to physical activity and compare the influence of the cultural environment with influences of the physical and social environments in racially or ethnically diverse samples of adolescent girls and boys.

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