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## The role of physical activity enjoyment in the pathways from the social and physical environments to physical activity of early adolescent girls

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### Abstract

Most girls experience a notable decline in physical activity (PA) in early adolescence, increasing their risk for harmful health outcomes. Enjoyment for PA (i.e., positive feelings toward PA) is a determinant of PA among girls during adolescence and sustained PA throughout adulthood. Previous studies recommended increasing girls' PA enjoyment in order to increase their PA, but did not include environmental-level strategies for how families, schools, or communities do this. To gain insight on such strategies, this study examines the role of PA enjoyment as a mediator of social and physical environments to moderate-to-vigorous intensity PA of early adolescent girls. Cross-sectional, secondary analyses, using structural equation modeling, were conducted on a U.S. national dataset of 1,721 sixth grade girls from the Trial of Activity for Adolescent Girls in 2003. Mediation model fit parameters included  $\chi^2(292, N=1721)=947.73$   $p<.001$ , CFI=0.95, RMSEA=0.04 (90% CI=0.03, 0.04), and SRMR=0.037 suggesting overall good fit. There were no indirect effects on PA through PA enjoyment from the social or physical environmental factors. To PA, there were significant direct effects only from social support from friends ( $\beta=.15$ , CI=0.09,0.22). To PA enjoyment, there were significant direct effects from social support from family ( $\beta=.15$ , CI=0.08,0.23), school climate (teachers  $\beta=.15$ , CI=0.10,0.21) boys  $\beta=.15$ , CI=0.09,0.20), and neighborhood environment ( $\beta=.10$ , CI=0.04,0.17). The findings of this study identified several direct effects of the social and physical environment on PA enjoyment that can begin to inform environmental-level strategies for increasing PA enjoyment among early adolescent girls.

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**Conflicts of interest**

None

## Keywords

physical activity; adolescence; girls; neighborhood; social support

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## Introduction

In 2013, only 27 % of adolescents (age 10-19) met the physical activity (PA)<sup>a</sup> recommendations of 60 minutes of PA a day.<sup>1</sup> Another 14 % of adolescents participated in no PA in the past week.<sup>1</sup> Regular PA, especially of a moderate-to-vigorous intensity, is positively related to many physical health outcomes (e.g., healthy body weight, and low rates of chronic disease).<sup>2</sup>

Health behaviors throughout childhood, including PA, are predictive of health behaviors throughout adulthood.<sup>3</sup> Studies have found that the greatest decline in PA occurs between childhood and adolescence, particularly among girls.<sup>4-7</sup> The rate of PA decline in early adolescence (10-14 years old) is also greater for girls than boys. From 12 to 15 years old, the mean minutes of moderate-to-vigorous PA decreases to a third of the mean minutes of PA among six to 11 year olds.<sup>4</sup> There is a gender disparity as well, as girls tend to have lower PA levels than boys for all ages.<sup>4,5</sup> Early adolescent girls have an immediate, high risk of becoming inactive and increasing their lifelong risk for harmful health outcomes.

The construct, PA enjoyment (i.e., a positive feeling toward PA; believing PA is fun), is an important determinant of girls' PA.<sup>8</sup> The more a girl enjoys PA the more likely she is to engage in PA. Studies show that PA enjoyment is not only an important determinant of PA among early adolescent girls<sup>9-12</sup>, it also stands out from other determinants because of its intrinsic nature and relationship to long-term PA.<sup>13,14</sup> PA enjoyment is a type of intrinsic motivation to perform PA (i.e., PA is internally satisfying or engaging in PA has value in and of itself).<sup>14</sup> Studies show that this type of motivation for PA is more predictive of sustained PA engagement, compared with other types of motivation (e.g., extrinsic), likely because it does not rely on external rewards or circumstances that may change frequently.<sup>13,14</sup> The more a girl enjoys PA, the more likely she is to participate regularly in PA and continue to participate in PA over time, greatly reducing her risk of poor health outcomes.<sup>2,13,14</sup>

Many studies recommend increasing girls' PA enjoyment in order to increase their PA, but do not present environmental-level strategies (i.e., strategies that can effect change across groups or populations rather than focusing on an individual) for how families, schools, or communities could do this. In addition to focusing on demographic characteristics (e.g., gender and race/ethnicity<sup>15-19</sup>) or individual-level constructs (e.g., self-efficacy, self-management, outcome expectancy<sup>19,20</sup>) related to PA enjoyment, research is needed on the social and physical environments that contribute to PA enjoyment, and in turn the PA of girls in order to inform new, environmental-level strategies to prevent the decline in PA among girls in the short- and long-term.

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<sup>a</sup> CFI, Comparative Fit Index; CI, confidence interval; df, degrees of freedom; PA, physical activity; RMSEA, Root Mean Square Error of Approximation; SD, standard deviation; SE, standard error; SRMR, Standardized Root Mean Square Residual; TAAG, Trial of Activity for Adolescent Girls.

The literature on PA interventions among adolescent girls points toward a potential mediating role of PA enjoyment.<sup>10,21,22</sup> Several theories identify determinants of PA. The Socio-Ecological Model of Health Behaviors and the Social Cognitive Theory define multiple social and physical environmental influences on PA.<sup>23,24</sup> Erickson's Theory of Psychosocial Development explains as youth transition into adolescents, awareness of their surroundings increases; and the relative value placed on the opinions and beliefs of their friends, compared with their family, increases.<sup>25</sup> This body of literature and theories informed the following study objective and hypotheses.

The objective of this study was to examine the role of PA enjoyment in the pathways from the social (e.g., supportiveness for PA from family, friends, peers, and teachers) and physical (e.g., conduciveness of a girl's neighborhood for PA) environments to moderate-to-vigorous intensity PA among early adolescent girls in order to elucidate environmental-level leverage points to foster sustained PA of girls over time. We hypothesized that social support from family and friends, school climate (i.e., perceived attitudes, beliefs, and behaviors of teachers and boys at school), and the neighborhood (i.e., built environment features and perceived safety of the area around a girl's home) environment will have indirect effects on moderate-to-vigorous intensity PA, mediated by PA enjoyment. Further, we hypothesized that peer influence (i.e., social support from friends and school climate related to boys) will show stronger positive associations with PA enjoyment compared with other environmental influences.

## Methods

### Data

To examine the role of PA enjoyment as a mediator of the effects of social and physical environments on moderate-to-vigorous intensity PA of early adolescent girls, we performed secondary data analyses using the Trial of Activity for Adolescent Girls (TAAG), a diverse, national dataset of early adolescent girls in the United States.<sup>26</sup> Details of TAAG's study design and sample selection can be found in other studies.<sup>26,27</sup> Cross-sectional baseline data from sixth grade girls in Spring 2003, were selected for analysis in this study because sixth grade captures the central age for girls transitioning into adolescence from childhood (12 years old).<sup>27</sup>

### Study Variables

Moderate-to-vigorous intensity PA and PA enjoyment were the two endogenous variables in this study. Total day moderate-to-vigorous intensity PA was objectively collected by Computer Sciences Applications uniaxial accelerometers. The devices were initialized prior to being distributed to participants, and programmed to start data collection in 30 second intervals at 5:00 AM the day after participants received the accelerometers.<sup>28</sup> Participants were instructed to wear the accelerometers on their right hip at all times over seven days, except when sleeping or engaging in any activity that involves being submerged in water.<sup>26</sup> PA was assessed by calculating the mean minutes over six of the seven days that the accelerometer counts registered 1500/half minute (i.e., moderate-to-vigorous intensity movement).<sup>26</sup> In this study, PA is limited to moderate-to-vigorous intensity PA because

national PA guidelines for adolescents in the United States recommend that most of the 60 minutes of PA per day be of moderate-to-vigorous intensity.<sup>2</sup> Additionally, studies have identified the disparate decline in moderate-to-vigorous intensity PA among girls compared with boys, highlighting a need to identify pathways to reverse this decline.<sup>4,5</sup> Pate and colleagues imputed missing accelerometer data using the Expectation Maximization algorithm recommended by Treuth and colleagues.<sup>28–30</sup> Pate and colleagues found that for each participant over the six days PA was assessed, an average of 12 hours of missing data were imputed.<sup>28</sup>

All other variables were assessed in the self-report student questionnaire.<sup>26</sup> PA enjoyment (i.e., positive feelings toward PA) was assessed using an abbreviated Physical Activity Enjoyment Scale.<sup>31</sup> This abbreviated scale included seven items (e.g., When I am active I feel bored) with 5-point Likert scale response options (disagree a lot to agree a lot). Responses were reverse coded, so higher scores denote more PA enjoyment.<sup>19</sup> Other studies using the abbreviated Physical Activity Enjoyment Scale have found good model fit<sup>32</sup> and internal consistency ( $\alpha=0.86$ <sup>33</sup>). The student questionnaire and the accelerometer data were all collected between January and March 2003. The student questionnaire was completed within one class period. The accelerometer data were collected over a three-week timespan, with a different equivalently-sized group of sixth grade girls assessed during each week.<sup>28</sup>

Social support from friends and family, school climate, and neighborhood environment were the four exogenous variables in this study. Based on the Amherst Health and Activity Study,<sup>34</sup> a social support scale included four questions on how often a friend provided gestures or encouragement that facilitates PA during a typical week<sup>32</sup> (e.g., How often do your friends do physical activities or play sports with you?) and five questions on how often family did the same (e.g., How often has a member of your household encouraged you to do physical activities or play sports?). Previous studies have found the scale to have two factors, based on source of the support, with acceptable model fit<sup>33</sup> and good internal consistency ( $\alpha=0.75$  for social support from friends<sup>32</sup>;  $\alpha=0.81$  for social support from family<sup>32</sup>). School climate captured perceived attitudes, beliefs, and behaviors of teachers and boys at school related to girls' PA.<sup>35</sup> School climate was measured by a modified GRAD Study school climate scale.<sup>36</sup> The scale included six items (e.g., In my school, boys stare too much at girls who are being physically active) with 5-point Likert scale response options (disagree a lot to agree a lot). Responses were reverse coded, so higher scores denote a school climate more supportive of PA. Previous studies have found good model fit<sup>35</sup> but questionable internal consistency ( $\alpha=0.61$ <sup>37</sup>). Lastly, neighborhood environment was assessed using a combination of the Amherst Health and Activity Study and the Survey of Neighborhood, Life Satisfaction, and Physical Activity-neighborhood environment scale.<sup>34,38</sup> The scale included 10 items describing neighborhood built environment, safety, and aesthetic characteristics (e.g., There are sidewalks on most of the streets in my neighborhood) with 5-point Likert scale response options (disagree a lot to agree a lot). Good internal consistency was found ( $\alpha=.78$ ) using this scale among sixth grade girls.<sup>39</sup>

## Statistical Analyses

SPSS 22.0<sup>40</sup> was used for data management and descriptive analyses (e.g., frequency, mean, standard deviation (SD), skew, kurtosis). A skew and kurtosis between  $-2$  and  $2$  were considered within a normal distribution range.<sup>41,42</sup> Mplus<sup>43</sup> was used for confirmatory factor analyses and structural equation modeling including tests of mediation. Maximum Likelihood Robust estimation was used which has been shown to produce robust estimators even with non-normal data.

In preliminary analyses, a confirmatory factor analysis was conducted on each latent variable prior to testing the proposed research aims. The confirmatory factor analyses were guided by theory,<sup>44</sup> other studies that have conducted exploratory factor analyses or confirmatory factor analyses on the same measures,<sup>31,32,35,39</sup> and model modification indices. To confirm the consistency of the confirmatory factor models, one half of the sample was randomly selected (i.e., split-half analyses)<sup>45</sup> as the developmental sample and was used to build the confirmatory factor analyses and to make any necessary model modifications. In the full sample, the final confirmatory factor models were re-run to ensure that the fit indices remained acceptable.

The final measurement models confirmed by the confirmatory factor analyses were then used in the full structural model that tested PA enjoyment as a mediating variable in the pathways from the social and physical environments to moderate-to-vigorous intensity PA. Mplus uses the traditional Delta method of estimating standard errors for indirect effects to determine the statistical significance of proposed mediators.

Recommended criteria for determining good fit was used for all models.<sup>46</sup> Overall acceptable model fit was assessed with several fit indices including Comparative Fit Index (CFI) value greater than or equal to 0.95; Root Mean Square Error of Approximation (RMSEA) and Standardized Root Mean Square Residual (SRMR) values less than or equal to 0.06.<sup>46</sup> A non-significant ( $p > 0.05$ ) Chi-square value ( $\chi^2$ ) indicates good fit. Cronbach's alpha was calculated to estimate internal reliability for each factor with an alpha value of greater than or equal to 0.70 indicating good internal reliability.<sup>47</sup>

Previous studies have found that a sample of 200 is generally necessary for structural equation modeling and having larger samples may contribute negligible benefits to the results.<sup>45</sup> The mediation model in this study was tested with the full sample ( $N=1,721$ ). A larger sample size is likely to produce narrower confidence intervals, ensuring greater certainty in the parameters of the models, compared with a small sample size. However, a drawback of a larger sample size in structural equation modeling analyses is that the Chi-square test is likely to show poor model fit for all models because the test is strongly influenced by sample size. To make up for this drawback, other model fit indices were used in evaluating the results (e.g., CFI, RMSEA, SRMR).

## Results

The study participants ( $N=1,721$ ) were racially and ethnically diverse (22.3% Non-Hispanic Black; 26.0% Hispanic; and 51.8% Non-Hispanic White). All of the girls in the sample were

in the 6<sup>th</sup> grade. The mean age of the sample was 11.95 years (SD=0.48; minimum=10.62, maximum=14.59). Close to half (46.7%) of the sample received free or reduced-price lunch.

Table 1 presents the final models and fit indices of each measure in the full sample. The items specified to covary within the latent variable neighborhood environment, were informed by domains (safety, aesthetics, and facilities) defined by Evenson and colleagues and the theorized associations of the items within those domains.<sup>39</sup> The final models for PA enjoyment and school climate had good model fit; whereas social support and neighborhood environment had reasonably good model fit, with one to two of their fit indices slightly outside of recommended cut-offs. The internal reliability across all factors was acceptable to good, with the exception of school climate related to boys that had questionable internal consistency.<sup>48</sup> Appendix A displays the bivariate correlations by item. The three inter-item correlations for the factor boys were significant ( $p < 0.001$ ) and ranged from  $R = 0.306$ - $0.448$ . These inter-item correlations were generally lower than in the other factors. The inter-item correlation for the factor teachers was  $R = 0.694$ ,  $p < 0.001$ . Table 2 shows descriptive statistics for each item included in the final confirmatory factor models. Higher values for PA enjoyment, school climate, social support, and neighborhood environment indicate positive endorsements. Distributions did not show concerning skewness or kurtosis for the majority of the items and no items had missing responses that made up more than 10% of the total responses.

The results of the full mediation model included a significant Chi-square value ( $\chi^2(292, N=1721) = 947.73$   $p < .001$ ), but all other fit statistics including CFI=0.95, RMSEA=0.04 (90% CI=0.03, 0.04), and SRMR=0.037 suggested good model fit. Figure 1 visually displays all the direct and indirect pathways tested in the mediation model, as well as standardized factor covariance. For clarity, only the significant factor covariances were included in Figure 1. There were no statistically significant indirect effects of the social or physical environment variables on moderate-to-vigorous intensity PA through PA enjoyment. On moderate-to-vigorous intensity PA, there were significant direct effects only from social support from friends. On PA enjoyment, there were significant direct effects from teachers, boys, social support from family, and the neighborhood environment. Social support from friends had a significant direct effect on PA enjoyment only when examined independently, but the path estimate was no longer statistically significant when included in the full mediation model. The full mediation model accounted for 15 percent of the variance ( $R^2 = 0.151$ ) of PA enjoyment and only 2.5 percent of the variance of moderate-to-vigorous intensity PA ( $R^2 = 0.025$ ).

## Discussion

The purpose of this study was to assess the role of PA enjoyment in the pathways from social and physical environments to moderate-to-vigorous intensity PA among early adolescent girls. Inconsistent with our hypothesis and the emerging PA intervention literature among early adolescent girls,<sup>10,21,49</sup> this study did not find evidence of mediation by PA enjoyment in the pathways from the social and physical environments to moderate-to-vigorous intensity PA among this sample of sixth grade girls. Furthermore, other studies have reported a direct relationship between PA enjoyment and PA among early adolescent

girls, but such a relationship was not found in this sample.<sup>50,51</sup> This lack of direct relationship between PA enjoyment and moderate-to-vigorous intensity PA could have contributed to the absence of evidence of PA enjoyment's mediation between girls' social and physical environments and their moderate-to-vigorous intensity PA.

One possible reason for this lack of relationship found between PA enjoyment and PA could be the unsurprisingly low moderate-to-vigorous intensity PA in which this sample of girls engaged and the surprisingly high PA enjoyment they reported. The average daily minutes of moderate-to-vigorous intensity PA (mean=23.91, SD=12.05) is similar to the low values reported in other studies, and approximately 36 minutes fewer than national recommendations for daily moderate-to-vigorous intensity PA.<sup>4,28,52,53</sup> However, the mean PA enjoyment score for this sample was 4.31 (SD=1.08) out of 5, which is higher than scores found in other studies. Huberty, Dinkel, and Beets found that girls (ages 8-13 years) reported an average of 3.8 (SD=1.03) out of 5, using the same PACES measure to assess PA enjoyment as was used in this study.<sup>54</sup> Again using PACES, Schneider and Cooper divided their sample of adolescent girls by the median PA enjoyment score, 3.44.<sup>55</sup> Girls who scored higher than the median were categorized as having high PA enjoyment, which would account for the majority of the girls in the TAAG sample. The low average daily PA combined with a high average PA enjoyment score seen in this sample is unusual and may contribute to the non-significant association between PA enjoyment and PA.

Another possible explanation for this lack of relationship found between PA enjoyment and moderate-to-vigorous intensity PA comes from a group randomized control trial by Dishman and colleagues, which found that PA enjoyment mediated the effects of a school physical education intervention on girls' PA, but only through self-efficacy.<sup>49</sup> The current study may be missing a key sequential mediation variable similar to self-efficacy, that provides the link between PA enjoyment and PA among girls. Furthermore, because previous research, particularly intervention studies, cite the importance of PA enjoyment in promoting PA among early adolescent girls,<sup>9-12,21,33,49,56,57</sup> additional research on the effects of PA enjoyment on PA that parses various types (e.g., leisure, transport) and intensity-levels of PA could bring a more detailed understanding of the relationship. Previous studies have found distinct determinants of PA based on PA type, and PA enjoyment could behave similarly among early adolescent girls.<sup>13,39,58-60</sup> There is also mounting evidence showing the health benefits of light-intensity PA.<sup>61-63</sup> While light-intensity PA is not as beneficial to health as higher-intensity PA and is not as emphasized in the national PA guidelines for adolescents, it may be an important avenue for reducing sedentary time among early adolescent girls.<sup>2,64,65</sup>

Moreover, the relationship between PA enjoyment and moderate-to-vigorous intensity PA in other studies could have been driven by particular racial/ethnic or socioeconomic characteristics of the samples that are distinct from this study sample, which includes variability across these demographic groups. Other studies have also found differences in girls' daily average moderate-to-vigorous intensity PA by race/ethnicity and socioeconomic indicators (e.g., receipt of free/reduced-price lunch).<sup>28,52</sup> Future research could compare the association between PA enjoyment and PA across demographic groups of girls.

Even though the relationship of PA enjoyment in the context of the social and physical environments on moderate-to-vigorous intensity PA of girls was not found as hypothesized, the direct relationships identified from the social and physical environments to PA enjoyment provide more information than was previously known about factors associated with PA enjoyment among girls. Most studies have examined demographic characteristics and individual-level constructs associated with PA enjoyment among youth and adolescents.<sup>15–20</sup> However, one meta-analysis by Burns and colleagues did examine the effects of 10 school-based PA interventions on the PA enjoyment of adolescents.<sup>66</sup> While girls were not the focus of the study, it did endorse teachers' use of behavioral support strategies and the importance of creating an inclusive school climate for facilitating PA enjoyment, the latter especially among girls.<sup>66</sup> The present study builds a more multi-level understanding of PA enjoyment by identifying positive relationships of social and physical environmental factors with PA enjoyment of early adolescent girls, who are at an increased risk for inactivity and low PA enjoyment compared with boys of the same age.<sup>4,5</sup>

Peer influence (i.e., social support from friends and school climate related to boys) was hypothesized to have the strongest positive associations with PA enjoyment. While school climate related to boys did have a positive direct effect on PA enjoyment, it was nearly equal in magnitude to school climate related to teachers and social support from family. Surprisingly, social support from friends was the only variable related to PA and the only variable that was not related to PA enjoyment. Contrary to the hypothesis, the social support of friends may be more relevant to PA than PA enjoyment in this sample of girls. However, the variance of PA explained by the model was so small, that this finding between social support from friends and PA was statistically significant, but has questionable practical meaning. Overall, the study findings reflect the positive relationship among supportive social environments with teachers and boys at school and family at home with girls' PA enjoyment.

This study lends additional support to established social and physical environmental-level strategies that promote PA among girls<sup>67–72</sup> by demonstrating that PA enjoyment is also positively associated with environmental-level factors that inform those strategies. Environmental-level strategies can foster long-term PA enjoyment because they tend to be present in girls' lives long-term. For example, girls will likely live in the same neighborhood, attend the same school, and spend time with the same family members and friends for many years. Consistent exposure to supportive social and physical environments for PA enjoyment and PA, increases the likelihood that girls maintain PA enjoyment and PA beyond adolescence.<sup>3,73,74</sup> School-based strategies to facilitate girls' PA enjoyment echo those identified in Burns and colleagues' meta-analysis mentioned earlier. These highlight the important role of teachers in facilitating a supportive school environment for girls to be active, which includes fostering supportive behaviors from boys.<sup>19,66</sup> A systematic review found that teachers' behaviors such as, providing girls with a variety of non-competitive PA options and allowing them to choose what they would like to do, are positively related to girls' PA.<sup>75</sup> Parents can support girls at home by engaging them in PA, providing encouragement and positive feedback when girls do engage in PA, and providing instrumental support like transportation to-and-from practices or facilities.<sup>19,22</sup>



## Study Limitations and Strengths

Findings from this study should be considered in light of several limitations. For example, the cross-sectional nature of the baseline TAAG data cannot establish temporality of dependent and independent variables and thus, causality cannot be inferred. Two potential threats to external validity include the unusually high average PA enjoyment among this sample compared with other comparable samples of girls, and the 14 years that have passed since the time of data collection. Both potential threats may limit the current generalizability of the study findings.

Additionally, there are limitations related to measurement. First, as with all self-report data, the participants' responses are vulnerable to positive biases related to recall and social desirability. Second, the measure used to assess school climate had less than acceptable internal reliability among this sample and in another study,<sup>37</sup> which introduces some measurement uncertainty. The well-fitting model of school climate in the confirmatory factor analysis lessens concerns about factorial validity of the measure, but there is opportunity to develop, or at least refine, a measure of the school environment and its supportiveness for PA among early adolescent girls.

Despite these limitations, there are several strengths of the current study. For example, focusing on PA enjoyment is important because it is one of few determinants of PA that has been shown to be a predictor of PA, not only in adolescence, but over time.<sup>13,14</sup> This study builds on existing literature by identifying social and physical environment factors that could serve as promising leverage points from which families, schools, and communities could foster PA enjoyment among girls. Moreover, this study is unique in that it focused solely on early adolescent girls, who are developmentally different from late adolescent girls.<sup>76</sup> This characteristic as well as the large, diverse sample from across the United States strengthens the generalizability of the results to other sixth grade girls around the country. All of the variables in this study have acceptable-to-well-fitting measurement models, confirmed in this study and/or another study.<sup>32,35,39</sup> Lastly, using structural equation modeling to address the aim of this study is a strength over traditional regression approaches, which cannot estimate the inter-correlations between predictors in a single model.

## Conclusions

This study is novel in its testing of PA enjoyment as a mediator of the pathways from the social and physical environments on PA of early adolescent girls. This study also contributes to the existing literature by identifying several social and physical environmental factors associated with PA enjoyment. Uncovering these relationships between environmental-level factors and PA enjoyment begins to bring insight into environmental strategies that families, schools, and communities can focus on to promote PA enjoyment, in addition to PA, of early adolescent girls, who are at an increased risk for inactivity compared with boys.<sup>4,5</sup>

## Human rights

This research was conducted in accordance with the Declaration of Helsinki. The ethics review boards from the universities involved in TAAG granted approval to conduct the study

first in the fall of 2002 and every year of the study thereafter.<sup>77</sup> The Institutional Review Board at Washington University in St. Louis approved this secondary analysis (reference # 201406027).

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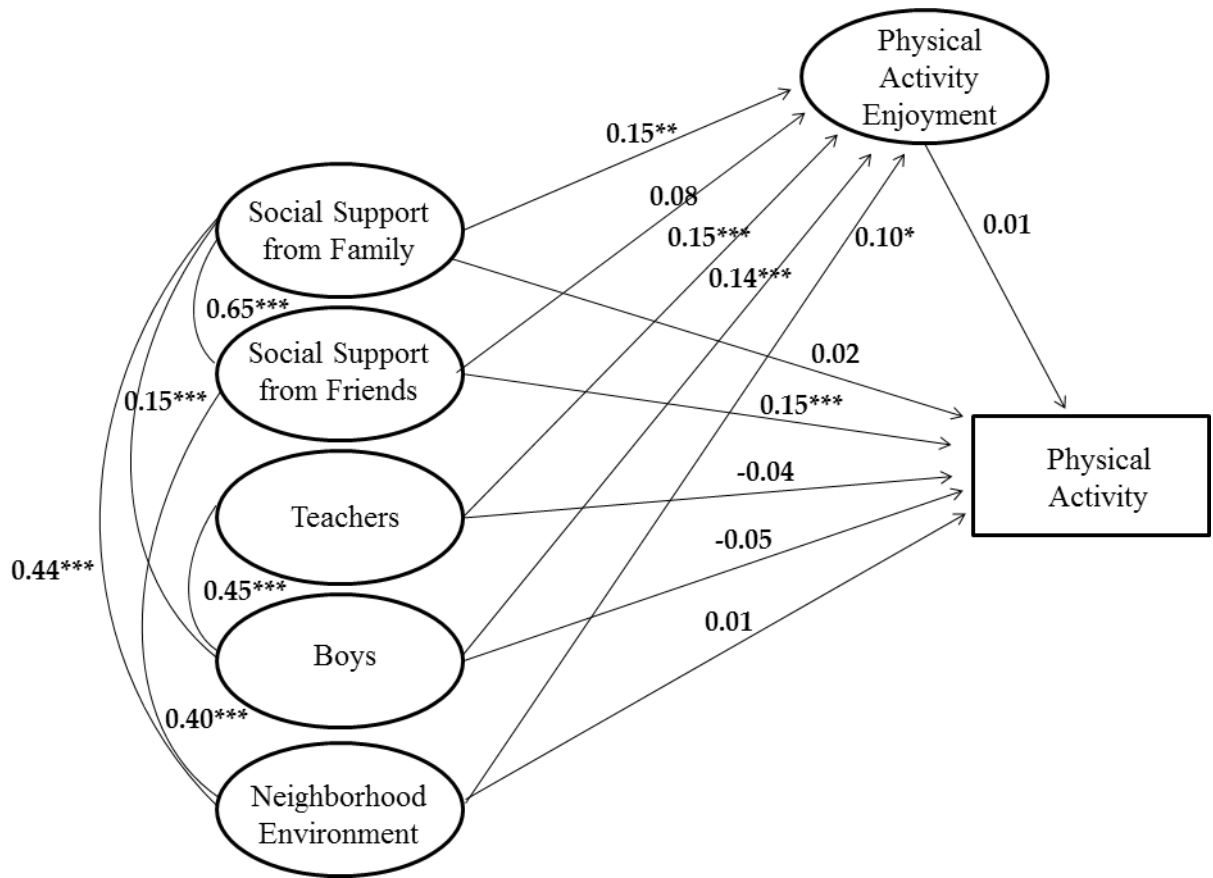


Figure 1. Mediation Model Results Using 2003 U.S. Trial of Activity for Adolescent Girls Dataset (N=1,721)

\* p<0.05, \*\*p<0.01, \*\*\*p<0.001

**Table 1**  
Final Confirmatory Factor Models and Fit Indices of Latent Variables Using the 2003 U.S. Trial of Activity for Adolescent Girls Dataset (N=1,721)

Variable: Final Model Description	# Items (# of factors)	$\chi^2$ (df)	P value	CFI	RMSEA (CI)	SRMR	Factor loadings	Factor & significant* item covariance	Alpha
Physical activity enjoyment	5 (1)	26.59 (4)	<0.001	0.99	0.06 (0.04-0.08)	0.01	0.69-0.81	item 6&7=0.16	0.86
Social support	8 (2)	181.69 (16)	<0.001	0.96	0.08 (0.07-0.09)	0.04	Friends: 0.65-0.73 Family: 0.54-0.79	factors=0.65 items 2&5=0.18 items 3&6=0.16 items 4&9=0.23	Friends: 0.72 Family: 0.82
School climate	5 (2)	7.51 (3)	0.06	1.00	0.03 (0.00-0.06)	0.01	Teachers: 0.77-0.90 Boys: 0.62-0.73	factors=0.47 items 4&5=-0.33	Teachers: N/A Boys: 0.66
Neighborhood environment	8 (1)	118.03 (13)	<0.001	0.94	0.07 (0.06-0.08)	0.03	0.40-0.55	items 4&5=0.17 items 4&8=-0.07 items 4&10=0.02 items 5&8=0.02 items 5&10=0.04 items 8&10=0.06 items 2&3=0.20	0.71

Note. TAAG: Trial of Activity for Adolescent Girls;  $\chi^2$ : Chi-square value (associated *p* value >0.05 indicates good model fit); df: degrees of freedom; CFI: Comparative Fit Index (value 0.95 indicates good model fit); RMSEA: Root Mean Square Error of Approximation (value 0.06 indicates good model fit); CI: Confidence interval; SRMR: Standardized Root Mean Square Residual (value 0.06 indicates good model fit); N/A: not applicable due to too few items to consider the factor a scale; Factor covariance indicates the correlation between the latent factors within each model when applicable; Item covariance indicates the error covariance between the items specified in the model

\* *p*<0.05

**Table 2** Distributions of the Final Study Items and Variables Using the 2003 U.S. Trial of Activity for Adolescent Girls Dataset

Variables and Items	N (N Missing)	Mean (SD)	Skewness (SE)	Kurtosis (SE)	Min	Max
<b>Physical Activity</b>						
Average daily minutes of moderate-to-vigorous physical activity	1721 (0)	23.91 (12.05)	1.29 (0.06)	2.42 (0.12)	2.61	87.78
<b>Physical Activity Enjoyment (removed items 4 &amp; 5)<sup>a</sup></b>						
1. When I am active I feel bored	1718 (3)	4.22 (1.16)	-1.38 (0.06)	0.80 (0.12)	1	5
2. When I am active I dislike it	1712 (9)	4.34 (1.02)	-1.56 (0.06)	1.63 (0.12)	1	5
3. When I am active it's no fun at all	1715 (6)	4.49 (0.98)	-2.06 (0.06)	3.55 (0.12)	1	5
6. When I am active it's not at all interesting	1699 (22)	4.45 (0.98)	-1.91 (0.06)	2.95 (0.12)	1	5
7. When I am active I feel I would rather be doing something else	1716 (5)	4.04 (1.24)	-1.10 (0.06)	0.03 (0.12)	1	5
<b>Social support (factors divided by source of support: family and friends; removed item 1)<sup>b</sup></b>						
2. How often do your friends encourage you to do the activity (friends)	1679 (42)	2.80 (1.15)	-0.04 (0.06)	-0.59 (0.12)	1	5
3. How often do your friends do the activity with you (friends)	1679 (42)	3.31 (1.11)	-0.39 (0.06)	-0.24 (0.12)	1	5
4. How often do your friends tell you, you are doing well in activities (friends)	1663 (58)	3.08 (1.24)	-0.19 (0.06)	-0.74 (0.12)	1	5
5. How often do family members encourage you to do PA(family)	1672 (49)	3.39 (1.14)	-0.37 (0.06)	-0.47 (0.12)	1	5
6. How often do family members do the activity with you (family)	1663 (58)	3.03 (1.08)	-0.15 (0.06)	-0.30 (0.12)	1	5
7. How often do family members do they provide transport to a place of recreation (family)	1661 (60)	3.51 (1.16)	-0.46 (0.06)	-0.36 (0.12)	1	5
8. How often do family members watch you participate in activity (family)	1661 (60)	3.36 (1.17)	-0.40 (0.06)	-0.44 (0.12)	1	5
9. How often do family members tell you, you are doing well in activities (family)	1665 (56)	3.68 (1.21)	-0.63 (0.06)	-0.45 (0.12)	1	5
<b>School Climate (factors divided by source: teachers and boys; removed item 3)<sup>c</sup></b>						



Variables and Items	N (N Missing)	Mean (SD)	Skewness (SE)	Kurtosis (SE)	Min	Max
1. In my school PE teachers think boy should be more active than girls (teachers)	1715 (6)	3.92 (1.30)	-0.86 (0.06)	-0.50 (0.12)	1	5
2. In my school other teachers think boys should be more active than girls (teachers)	1711 (10)	3.96 (1.23)	-0.87 (0.06)	-0.37 (0.12)	1	5
4. In my school boys make rude comments about girls who are active (boys)	1698 (23)	3.11 (1.44)	-0.04 (0.06)	-1.34 (0.12)	1	5
5. In my school being active around boys makes me uncomfortable (boys)	1708 (13)	3.73 (1.38)	-0.65 (0.06)	-0.93 (0.12)	1	5
6. In my school boys stare too much at girls being active (boys)	2716 (5)	3.07 (1.45)	-0.04 (0.06)	-1.34 (0.12)	1	5
<b>Neighborhood environment (removed items 6 &amp; 7)<sup>d</sup></b>						
1. There are many places I like to go within walking distance of home	1716 (5)	3.60 (1.33)	-0.69 (0.06)	-0.66 (0.12)	1	5
2. There are sidewalks on most of the streets in my neighborhood	1713 (8)	3.46 (1.65)	-0.49 (0.06)	-1.44 (0.12)	1	5
3. There are bike or walking trails in my neighborhood	1706 (15)	3.18 (1.59)	-0.22 (0.06)	-1.52 (0.12)	1	5
4. It is safe to walk or jog in my neighborhood	1672 (49)	3.97 (1.27)	-1.07 (0.06)	-0.00 (0.12)	1	5
5. Walkers and bikers can be seen easily by people in their homes	1698 (23)	3.81 (1.21)	-0.81 (0.06)	-0.25 (0.12)	1	5
8. I often see other kids playing outside in my neighborhood	1702 (19)	3.85 (1.33)	-0.93 (0.06)	-0.38 (0.12)	1	5
9. There are interesting things to look at in my neighborhood	1703 (126)	3.47 (1.30)	-0.49 (0.06)	-0.86 (0.12)	1	5
10. My neighborhood streets are well lit at night	1714 (6)	3.33 (1.43)	-0.34 (0.06)	-1.23 (0.12)	1	5

Note: All percentages are valid percentages; The confirmatory factor analyses were guided by theory, other studies that have conducted exploratory factor analyses or confirmatory factor analyses on the same measures, and model modification indices; TAAAG: Trial of Activity for Adolescent Girls; SD: Standard deviation; SE: Standard error

<sup>a</sup>item 4 is: When I am active it makes me depressed; and item 5 is: When I am active it frustrates me.

<sup>b</sup>item 1 is: How often do you encourage your friends to do physical activity.

<sup>c</sup>item 3 is: In my school most girls think it is important to be physically active.

<sup>d</sup>item 6 is: There is so much traffic that it is hard to walk in my neighborhood; and item 7 is There is a lot of crime in my neighborhood.