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The Role of Physical Activity Enjoyment in the Pathways from Social and Physical Environments to Physical Activity of Early Adolescent Girls

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by
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List of Abbreviations

AIC: Akaike's Information Criterion
BMI: body mass index
CFA: confirmatory factor analysis
CFI: Comparative Fit Index
CI: confidence interval
df: degrees of freedom
ML: maximum likelihood estimator
PA: physical activity
RMSEA: Root Mean Square Error of Approximation
SCT: Social Cognitive Theory
SE: standard error
SEM: structural equation modeling
SES: socioeconomic status
TAAG: Trial of Activity for Adolescent Girls

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Dedicated to my parents, my many sisters, and VJS.

ABSTRACT OF THE DISSERTATION

The Role of Physical Activity Enjoyment in the Pathways from Social and Environmental Factors to Physical Activity of Early Adolescent Girls

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In 2013, only 27.1 % of adolescents (age 10-19) met the daily physical activity (PA) recommendations of 60 minutes of PA a day. [1] Inactivity is highly prevalent among youth and especially prevalent among adolescents. This inactivity can have harmful and costly, immediate and long-term repercussions on physical, mental, and social health.[2–8] Health behaviors throughout childhood, including PA, are predictive of health behaviors throughout adulthood.[9] Girls experience the steepest decline in PA in early adolescence compared to boys and any other age group, which positions them on a lifelong trajectory of inactivity and increased risk for disease.[2,4] Among early adolescent girls, those of a minority race/ethnicity, low socioeconomic status, and who are overweight experience even greater declines in PA and are the least active of their age group.[10–12] Enjoyment for PA (i.e., positive feelings toward PA) is a critical determinant of PA among girls during adolescence and sustained PA throughout adulthood.[13–15] However, studies have not yet examined the role of PA enjoyment in models of the effects of social (e.g., friend and familial social support) and physical (e.g., neighborhood characteristics) environments

on the PA of early adolescent girls (Aim 1), and how these pathways may differ by race, socioeconomic status, and body fat percentage (Aim 2). This study tests these aims through secondary data analysis of the Trial of Activity for Adolescent Girls, a diverse, national dataset of 1,721 early adolescent girls.[16,17] Accompanied by other studies on PA enjoyment and PA, the findings of this study can inform strategies and programs for increasing PA enjoyment and PA among adolescent girls. Fostering social support from friends may be a priority strategy for PA promotion among girls who are Non-Hispanic White. Building a supportive neighborhood environment and training teachers on how to facilitate a supportive school environment may be key factors for promoting PA enjoyment among sub-groups of girls at the highest risk for inactivity (e.g., Hispanic, non-Hispanic black, low SES, or above average body fat percentage). Longitudinal research that examines the full causal model of pathways to PA enjoyment and PA by sub-groups of early adolescent girls is needed.

Chapter 1: Significance of the Problem

1.1 Physical Activity, Health, & Achievement

More than half (58 %) of U.S. youth are not meeting the daily physical activity (PA) recommendations.[2,3] In 2013, only 27.1 % of adolescents (age 10-19) met the daily PA recommendations of 60 minutes of PA a day. [1] Another 14 % of adolescents participated in no PA in the past week.[1] Inactivity is highly prevalent among youth and especially prevalent among adolescents. This inactivity can have harmful and costly, immediate and long-term repercussions on physical, mental, and social health.[2–8]

Regular PA is positively related to a number of physical health outcomes including but not limited to: muscle and bone strength, cardiovascular endurance, healthy body weight, low cholesterol and blood pressure.[7] The National Cancer Institute (NCI) reports strong evidence linking PA with a reduced risk of many types of cancer.[18–20] Women who increase their PA to the recommended minutes per week can reduce their risk of colon cancer by 30-40 %, endometrial cancer by 20-40 %, and breast cancer by 20-80 %.[18–20] Studies suggest that a lifetime of regular moderate-to-vigorous PA, especially throughout adolescence, has a greater protective effect against breast cancer compared to engaging in PA only later in life.[18–20] Across all ages, PA also lowers the risk of obesity, a well-established risk factor for several types of cancer, type 2 diabetes, cardiovascular disease, and heart disease.[4–6,21,22] These obesity-related diseases in adulthood are to blame for more than a quarter of the increase in medical spending of United States residents over the past two decades.[23]

Regular PA is also inversely related to mental health outcomes like, stress, depression, and anxiety.[7] This relationship is especially relevant to adolescents; one in eight adolescents is diagnosed with anxiety disorders.[24] Anxiety disorders alone costs the U.S. 42 billion dollars a year, which is a third of the total cost of mental health disorders. [24]Another aspect of psychological health is self-perception. PA is positively related to a number of self-perceptions including but not limited to: self-esteem and perceived physical competence (i.e., feeling like one would be successful performing an activity).[7,25]

Physical activity is increasingly being linked to academic achievement in school. For example, inactive adolescents are twice as likely as active adolescents to have poor perceptions of their academic performance[8] and PA may contribute to this difference. Active adolescents show higher attentiveness in school than their inactive counterparts.[26] A recent report showed that girls who engage in at least a 15 minute walk to school had higher cognitive functioning during school than girls who had no PA before school.[27] Likewise, a three year study found that schools that employ activity breaks throughout the day see a significant improvement in focus and academic achievement among their students.[28]

Active adolescents also engage in risky behaviors at lower rates compared to inactive adolescents.[8,29–31] For example, a study found inactive adolescents have 1.5 the odds of: smoking one or more cigarettes in the past 30 days; smoking marijuana one or more times in the past 30 days; and not wearing a seat belt.[8] Likewise, inactive adolescents eat fewer fruits and vegetables, have more sexual partners in the last three months, and spend more time in front of a TV or video game per day compared to active adolescents. [8]

1.2 Disparities in Physical Activity

Health behaviors throughout childhood, including PA, are predictive of health behaviors throughout adulthood.[9] Many studies have found that the greatest decline in PA occurs between childhood and adolescence.[4,32–34] As youth age into adolescence, 12 to15 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.[4] Moreover, adolescents who are Asian, Black or Hispanic participate in PA fewer days per week than adolescents who are White.[35] A greater proportion of adolescents of a minority race/ethnicity also report doing no PA in the last week compared to their White peers.[7]

The disparities in PA levels vary based on age and race for boys and girls, but one finding remains consistent: girls tend to have lower PA levels than boys for all ages and racial groups.[2,4,32,35] The rate of PA decline from childhood to adolescence is also greater for girls than boys. [2,4,32,35]Among this early adolescent age group (10-14 years old) of girls at an increased risk of inactivity compared with boys and other ages, there are further disparities in PA by race, socioeconomic status (SES), and body composition. Black and Hispanic adolescent girls are the least active of boys and girls of all ages and race/ethnicities in the U.S.[7] Girls from low SES households are less active than girls from middle/upper SES households and body fat percentage is inversely related to PA among girls.[10–12] These demographic characteristics by which PA varies among girls are not mutually exclusive. Black and Hispanic girls are disproportionately represented in low SES households and have higher average BMI and body fat percentages than girls who are White or live in middle/upper SES households.[36,37] All in all, early adolescent girls, especially those of a minority race/ethnicity, from a low SES household, and/or with a high

body fat percentage have an immediate, high risk of becoming inactive and increasing their lifelong risk for harmful physical, mental, and social health outcomes.[2–8]

1.3 Physical Activity Enjoyment and Gaps in Empirical Knowledge

Physical activity enjoyment (i.e., a positive feeling toward PA; believing PA is fun) is an important determinant of girls' PA.[38] 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[13,15,39–42], it also stands out from other determinants because of its intrinsic nature and relationship to long-term PA.[43,44] 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).[44,45] Studies show that this type of motivation for PA is more predictive of sustained PA engagement, compared with all other types of motivation (e.g., extrinsic), likely because it does not rely on external rewards or circumstances that may change frequently.[43,44] 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.[7,8,14,24,43,46]

Unfortunately, like PA, girls report less PA enjoyment than boys [47,48]and a two year longitudinal study found that PE enjoyment declined for girls between the fourth and sixth grade while boys reported no change of enjoyment.[38] One study showed that Black and Hispanic girls report less PA enjoyment than white girls,[49,50] but whether PA enjoyment also varies by other demographic characteristics is unknown. Many studies recommend increasing girls' PA enjoyment in order to increase their PA and improve their immediate and long-term health outcomes, but fail to present population-level, environmental strategies for how families, schools, or communities could do

this.[40,42,51–53] More research on the social and physical environments that contribute to PA enjoyment, and in turn the PA of girls is needed to inform new strategies to prevent the decline in PA among girls in the short and long-term.

1.4 Study Aims & Potential Impact

Research on the role of PA enjoyment in relation to the social (e.g., supportiveness for PA from family, friend, and those at school) and physical (e.g., conduciveness of a girl's neighborhood for PA) environments and PA would help to identify pathways to sustained PA of girls over time. Furthermore, how these pathways may vary by race, SES, and body fat percentage could contribute to tailored environmental strategies for families, schools, and communities to increase the PA of girls at highest risk for inactivity and poor health outcomes (see Figure 1.1, Conceptual Framework).

The aims of this study, *The Role of Physical Activity Enjoyment in the Pathways from Social and Physical Environments to Physical Activity of Early Adolescent Girls*, are the following:

Aim 1: Examine PA enjoyment as a partial mediator of the effects of social and physical environments on PA among early adolescent girls.

Hypothesis 1.1: Social support from family and friends, school climate (i.e., support from 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 direct and indirect effects on PA, mediated by PA enjoyment.

Hypothesis 1.2: Peer influence (i.e., social support from friends and school climate related to boys) will have the strongest positive associations with PA enjoyment.

Rationale: The Socio-Ecological Model of Health Behaviors and the Social Cognitive Theory defines multiple social and physical environmental influences on behavior, which informed hypothesis 1.1.[54,55]The emerging literature on PA interventions among adolescent girls informed the hypothesized partial mediation in hypothesis 1.1.[40,51,53] Erickson's Theory of Psychosocial Development explains that 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.[56] Erickson's theory informed hypothesis 1.2.

Aim 2: Examine whether race, SES, and body fat percentage moderate the direct and indirect effects of social and physical environments on PA through PA enjoyment.

Hypothesis 2.1: Race will moderate the total effects of social and physical environments on PA; the effect of social support from family will be less influential among black and Hispanic girls vs. white girls.

Hypothesis 2.2: SES will moderate the total effects of social and physical environments on PA; the effect of neighborhood characteristics will have a stronger effect among low SES girls vs. higher SES girls.

Rationale: Research on these environments and how they differ by groups of girls informed Aim 2 hypotheses. For example, black and Hispanic girls perceive less social support for PA compared to their white counterparts (hypothesis 2.1).[49] Similarly, girls of lower SES have poorer perceptions of their neighborhood environment than girls of higher SES (hypothesis 2.2).[57]

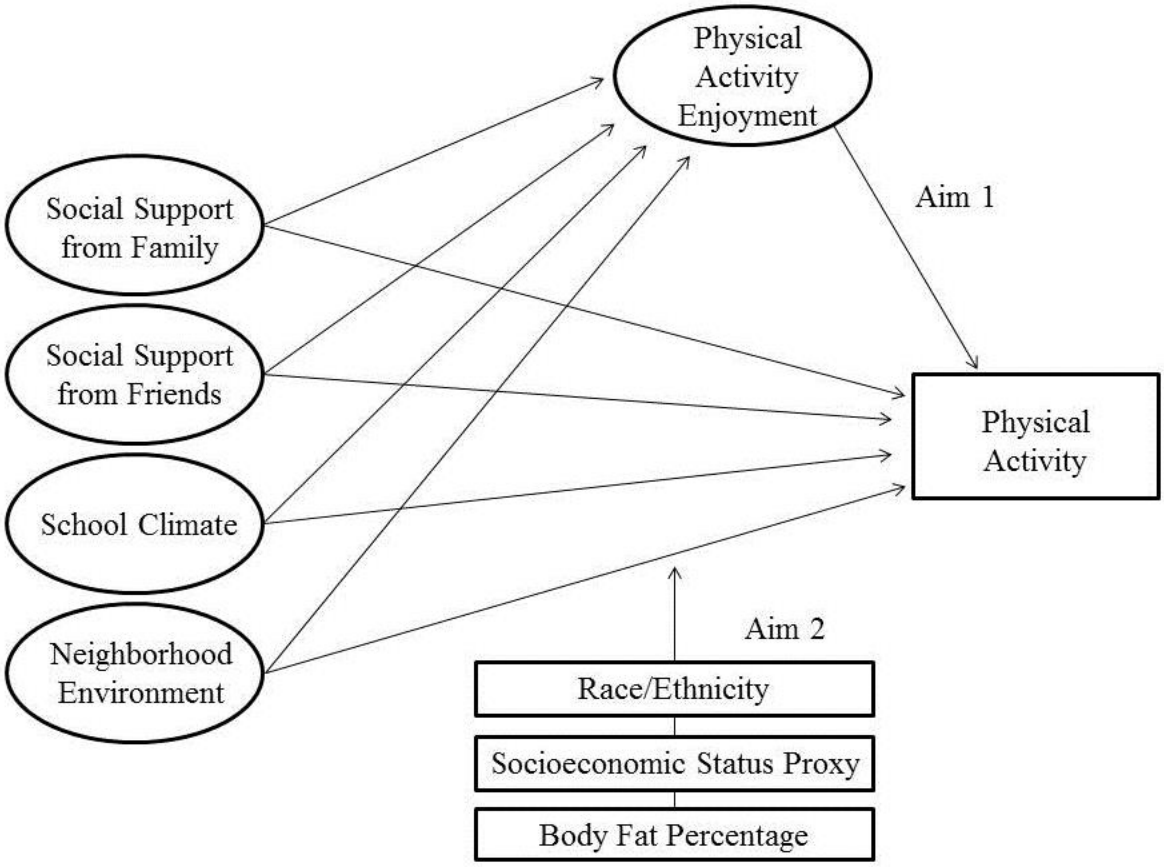

Figure 1.1 Conceptual Framework

These aims are assessed through secondary data analysis of the Trial of Activity for Adolescent Girls (TAAG), a racially and socioeconomically diverse, national dataset of early adolescent girls.[16,17] This study is the first to examine PA enjoyment as a partial mediator of the effects of social and physical environments on the PA of early adolescent girls. This study also aims to provide insight to how girls of various races, SES, and body fat percentages may experience these pathways to PA differently; further unpacking the disparities seen in PA enjoyment and PA.[49] Accompanied by the broader literature, findings from this study lay the groundwork for creating strategies specifically designed for increasing PA enjoyment and PA among early adolescent girls at highest risk for inactivity, reducing their heightened risk of poor physical, mental, and social health outcomes.[7,8,14,24,43,46] Research shows that strategies tailored to specific

demographic groups, behaviors, or circumstantial characteristics of individuals or groups are more effective at creating behavior change and have greater potential for reducing health disparities compared to "one size fits all" interventions.[58,59] Investing in research and subsequent tailored programs and policies focused on altering the social and physical environments that contribute to girls' PA by way of a girls' PA enjoyment may have greater potential for narrowing population-level disparities in PA than through other determinants of PA that show no evidence of sustained effects on behavior.

Chapter 2: Key Concepts & Background

This chapter operationalizes important concepts for the upcoming chapters and expounds on the justifications for focusing on girls' PA enjoyment and their social and physical environments in relation to PA.

2.1 Key Concepts

Adolescence constitutes ages 10 through 19 years.[60] In 2011, there were 19,989,000 adolescent girls in the U.S., which is just over six percent of the population.[61] Certain studies refer to early adolescence, which is considered ages 10 through 14 years.[25,62] It is common for studies on PA among adolescent girls not to distinguish between early versus late adolescents and/or to lack deliberateness in their sample selection by age within the range of adolescence.[63–67] This remains the case even though there are a number of developmental differences between early and late adolescent girls (e.g., lower self-esteem, increased identification with gender roles, and increased cognitive ability as girls age), which indicate that the two groups should be targeted separately.[68–70] Also, a recent study examined correlates of moderate-to-vigorous intensity PA among early and late adolescent girls and found differences (e.g., higher social support from friends was positively related to PA for early adolescent girls, but not late adolescent girls).[62] There is opportunity for further research on the potential moderating effects of age within adolescence on various modifiable correlates of PA. Since the decline in PA among adolescent girls begins to occur in early adolescence,[4] efforts toward the prevention of this decline should be more heavily focused on and tailored to early adolescent girls compared to later adolescent girls;

yet this is not the case. This study responds to this gap in the empirical knowledge by focusing completely on early adolescent girls (all in the sixth grade; mean age=12 years).[16]

Physical activity (PA) refers to moderate-to-vigorous intensity PA, which is often described as movement that causes increased heart rate, sweating, and/or heavy breathing. While there are a wide variety of examples of moderate and vigorous intensity PA, walking is an example of moderate intensity PA and running is an example of vigorous intensity PA. The U.S. Department of Health and Human Services recommends that children and adolescents participate in at least 60 minutes of PA a day.[7] The Centers for Disease Control and Prevention recommends that within these 420 minutes of PA a week, children and adolescents should take part in a combination of cardiovascular (e.g., brisk walking or running), muscle building (e.g., push-ups), and bone strengthening (e.g., jumping jacks) PA.[10] In 2011, only 18.5 % of U.S. adolescent girls and 38.3 % of adolescent boys reported meeting the daily recommended minutes of PA in the past week.[1]

Mediation and moderation are terms that relate directly to Aim 1 and Aim 2 respectively. A mediator is a variable that connects two other variables (e.g., an independent and dependent variable) to each other in the causal pathway.[71] A mediator can be a full mediator, which means that the independent variable has no direct effects on the dependent variable, and is only connected to the dependent variable indirectly through the mediating variable. A partial mediator is when the independent variable has direct effects on the dependent variable and indirect effects on the dependent variable through the mediating variable. A moderator is a variable by which the pathways between the independent variable and dependent variable vary.[71] For example, age is

inversely related to PA as youth age into adolescence, but the rates at which PA declines as youth age is greater among girls than boys.[2,4,32,35] In this case, gender is a moderator by which the pathway between age and PA vary.

2.2 Determinants of Physical Activity

The determinants of PA among adolescent girls are diverse and widespread. Some determinants are un-modifiable (e.g. race/ethnicity) or less modifiable (e.g. socioeconomic status) compared to more modifiable determinants like, PA enjoyment or presence of neighborhood streetlights. For example, a systematic review on the determinants of change in PA by Craggs and colleagues found gender consistently related to PA change, where girls showed more substantial declines in PA than boys. The same review also found maturation related to PA change. The onset and progression of puberty is inversely associated with PA among girls and boys.[72] These un-modifiable determinants of PA are often helpful in defining priority or target populations for studies and interventions.

Most determinants are modifiable and present abundant opportunities for public health researchers and practitioners to intervene and facilitate changes that promote PA among girls. There are modifiable determinants of PA for adolescent girls related to their social and physical environments. A study that used TAAG data found that the most common physical and social contexts in which girls engage in PA were at home or in their neighborhood and with at least one other person.[73] The study recommends that intervention strategies to increase PA among early adolescent girls meet the girls where they are, which would include building on their current

social support system and promoting PA that can be done close to home. The following is an overview of the social and physical environments that influence the PA of adolescents and, more specifically early adolescent girls, when available in the literature.

2.2.1 The Social Environment

A girl's social environment has to do with her interactions with others including: parents, siblings, teachers, coaches, and especially girls and boys their own age.[42] Stankov, Olds, and Cargo conducted a systematic review of qualitative studies on barriers (negative correlates) to PA among overweight or obese adolescents.[74] Barriers related to the social environment generally fit into two categories: 1) lack of social support from family and friends, and 2) perceived and actual negative reactions from peers.[74]

Social support is defined as "supportive behaviors or acts" and described in a model of The Relationship of Social Networks and Social Support to Health as, "the starting point or initiator of a causal flow toward health outcomes" (pp. 189).[75] In this case PA is the positive health outcome or behavior. Lack of social support from family and friends can mean: lack of emotional support (e.g. encouragement), lack of instrumental support (e.g. rides to sports practice), lack of informational support (e.g. sharing knowledge on how to perform a particular type of PA), lack of companionship support (e.g. engaging in PA together), and lack of observational support (e.g. a parent models PA).[75–77] Parents can also provide support for their daughters' PA by allowing them to spend time doing physical activity outdoors, around the neighborhood.[42] Many quantitative studies have also found social support to be a determinant of adolescent PA.[42,78] Hashim found that adolescent girls' PA is positively related to social support

from their mothers, but not their fathers.[79] The same study also found that the relationships among the types of social support and PA vary by gender. Hashim found that boys' PA is only positively related to instrumental support, while girls' PA is only positively related to emotional support.[79]

Perceived and actual negative reactions from peers include: verbal or physical bullying, stereotyping, and social exclusion.[74] An extensive, qualitative study that involved middle-school girls and boys sharing their thoughts on girls doing PA provided examples of these negative reactions from peers.[80] The study found that both girls and boys perceived physically active girls as aggressive, competitive, and as being Tomboys.[80] Girls cited boys' negative attitudes and behaviors (e.g. teasing) toward active girls as a particularly influential barrier to their PA.[80] In contrast, girls also noted the positive influence of familial and peer support for PA as strong facilitators of their PA.[80,81]

The literature is inconsistent on friends' and family members' PA as a determinant of PA among adolescent girls. Anderssen and Wold found friends' and parents' PA to be positively related to girls' PA.[82] Sallis, Prochaska, and Taylor found siblings' PA positively related to adolescents' PA.[42] Conversely, Van der Horst and colleagues found a positive relationship between parents' PA and boys' PA, but no such relationship between parents' PA and girls' PA.[78] Hashim found no relationship between parents' or friends' PA and girls' or boys' PA.[79] Ornelas, Perreira, and Ayala identified a complexity of the relationship that could be one possible explanation for the inconsistent findings across studies.[83] Ornelas and colleagues found self-esteem to be a mediator of parents' PA and adolescents' PA. They also found significantly lower levels of self-esteem

among girls compared to boys.[83] This is the case for PA enjoyment between girls and boys as well, but the potential mediating role of PA enjoyment has not yet been tested in regard to the pathways from the social environment to PA among early adolescent girls. Only one qualitative study of 10 and 11 year old adolescents concluded that friendship groups influence PA enjoyment, PA initiation, and PA maintenance.[84]

2.2.2 The Physical Environment

Likewise, the more supportive or appealing a girl's physical environment is for PA, the more likely she is to engage in PA.[73,85] Close proximity of destinations (e.g., stores, restaurants, school), connectivity of sidewalks, and presence of traffic calming features (e.g. medians, speed limit signs, speed bump) are built environment factors that contribute to overall walkability (i.e. how supportive an area is of walking) and perceived walkability of a neighborhood.[86] In a study by Patnode and colleagues, girls were found to be more sensitive to their physical environments than boys.[87] In this case, the perceived walkability of a neighborhood and proximity of school from home were both significantly, positively related to PA among girls, but not among boys. [87] Another study found that neighborhood walkability was significantly inversely related to PA among adolescents living in low SES neighborhoods.[88] Further, Floyd and associates found that the availability of parks, and the recreational facilities (e.g. basketball courts) and organized PA within the parks were all positively related to PA levels among youth and adolescents regardless of the neighborhood characteristics (e.g. racial diversity of residents, residence density).[89]

Table 2.1 includes 1) the operationalizations of the four social and physical environment variables in this study, 2) the relationships between the four variables and the PA of early

adolescent girls, and 3) how the four variables have been found to vary by race/ethnicity, SES, body fat percentage. The table highlights the need to explore how girls with different body compositions experience their social and physical environments as they relate to their PA. The table also informs the Aim 2 of this study, suggesting that if PA and the social and physical environments vary by demographic characteristics of girls, there is reason to hypothesize that the pathways from the social and physical environments and PA enjoyment, to PA vary by demographic characteristics as well.

Table 2.1 Social and Physical Environments and their Relationships with Physical Activity of Early Adolescent Girls and Demographic Characteristics

Variable	Operationalization	Variable and its Relationship with PA	Variable and its Relationship with Race/Ethnicity, SES, and Body Fat Percentage
Social Support from Friends	Gesture or encouragement from peers that facilitates engagement in PA[90]	+ relationship with PA[42,78,80]	• SES (low SES adults perceived less social support compared to upper SES adults)[91,92] • Race/Ethnicity (Hispanic women perceived more social support than non-Hispanic women)[93] • Body fat percentage (not yet been examined in relationship to social support from friends)
Social Support from Family	Gesture or encouragement from people in one's household that facilitates engagement in PA[90]	+ relationship with PA[25,74,91,92]	• Race/Ethnicity (Hispanic girls reported lower social support from family than white girls)[49] • Race/ethnicity (Black girls reported higher family involvement in PA than white girls)[94] • Race/Ethnicity (Hispanic women perceived more social support than non-Hispanic women) [93] • SES (low SES adults perceived less social support compared to upper SES adults)[91,92] • Body fat percentage (not yet been examined in relationship to social support from family)
School Climate	Perceived attitudes, beliefs, and behaviors of teachers and boys at school related to girls' PA[95]	+ relationship with PA[50,80]	• Race/Ethnicity (black girls reported poorer perceived attitudes from teachers than white girls; Hispanic girls reported poorer perceived attitudes from male classmates than white girls)[49] • Body fat percentage (overweight early adolescents experienced more weight teasing from classmates than normal weight early adolescents)[96]
Neighborhood Environment	Perceived built environment, safety, and aesthetic conditions related to PA of the area around one's home[97]	+ relationship with PA[98,99]	• Race/ethnicity (Black girls reported lower perceived safety of the neighborhood than white girls)[94] • SES (low SES adults perceived less supportive neighborhood environments compared to upper SES adults)[91,92] • Body fat percentage (overweight in adults was positively associated with urban sprawl)[99]

Note. + indicates a positive relationship; - indicates negative

2.2.3 Physical Activity Enjoyment

The current qualitative literature shows that PA enjoyment is an important determinant of PA among early adolescent girls and as they age into adulthood. A systematic review of 19 qualitative studies also identified PA enjoyment as one of the five most influential individual-level factors on girls' PA.[100] However, the role of PA enjoyment as it relates to girls' social and physical environments and PA, and how these pathways may vary by demographic characteristics have not yet been empirically tested. This study builds on the other studies that analyzed TAAG data as well as the broader literature regarding PA among early adolescent girls.

Barr-Anderson and colleagues tested several TAAG variables for their relationships with PE class enjoyment.[50] Variables that positively correlated with PE class enjoyment included: self-report leisure time PA, perceived benefits of PA, self-efficacy, and school climate related to teachers, while BMI was negatively related to PE class enjoyment. [50] They also found a difference in PE class enjoyment by race; black girls reported higher PE class enjoyment than white girls.[50] While there are intuitive similarities between PE class enjoyment and PA enjoyment (i.e., both involve positive affect toward PA) there are also reasons to examine them separately. PE takes place in school and typically involves highly structured and supervised PA with external rewards and punishment (e.g., grades, feedback from PE teacher).[50] A second TAAG study by Barr-Anderson and colleagues that examines PE class enjoyment and PA enjoyment in the same study provides additional support for making a distinction between the two variables.[101] PE class enjoyment had a positive relationship with girls' self-report structured PA (i.e., participation in afterschool sports/PA classes), but no such relationship as found with PA enjoyment and structured PA.[101] PA enjoyment is a more global construct that encapsulates

any and all PA (e.g., structured, unstructured, during school, after school, on the way to school, individual or team-based).[102] While PE is an important Institute of Medicine-supported method for increasing PA among adolescents[103], PE is limited to primary and secondary school years. Improving our understanding of PA enjoyment has more far-reaching (e.g., outside of school hours) and long-lasting (i.e., after high school) potential for impact on PA.

Two other TAAG studies found racial differences in PA enjoyment. Grieser and colleagues and Kelly and colleagues found that black and Hispanic girls reported lower PA enjoyment than white girls.[37,49] Grieser and colleagues adjusted for free and reduced-price lunch status and BMI in their study. These findings laid the foundation for the current study to further examine demographic groupings (race and others) among early adolescent girls and how the role of PA enjoyment in the pathways from the social and physical environments to PA may differ (Aim 2).[49] Grieser and colleagues raised the question of why there are racial differences in PA enjoyment. This study contributes toward answering this question by examining, 1) how the direct pathways from the social and physical environments to PA enjoyment may differ by sociodemographic characteristics; and 2) how the role of PA enjoyment in the pathways from the social and physical environments to PA may vary.[49] Identifying these differences by sub-groups of early adolescent girls, elucidates levers for influencing their behaviors.

In the broader literature, there is emerging evidence of PA enjoyment acting as a mediator in PA promotion interventions among early adolescent girls, but what conditions PA enjoyment is mediating remains unclear. A study by Dishman, Motl, Saunders, et al. evaluated an intervention that made changes to the curriculum and school environment in order to increase the PA of black

and white adolescent girls.[51] They found that the intervention effectively increased PE class enjoyment, which had a positive effect on PA enjoyment and self-efficacy. Both PA enjoyment and self-efficacy had direct effects on girls' PA.[51] Jago and colleagues conducted a qualitative study involving focus groups of early adolescent girls (from the United Kingdom) and interviews with parents.[40] The study examined what factors would most influence the recruitment and retention of girls into an afterschool dance program. Girls and parents both cited that PA sessions that foster enjoyment and include the girls' friends would be most supportive of girls staying engaged in the intervention.[40] Similarly, in a study by Ryan, Frederick, Lepes, & Rubio, the motives for participation in a PA program were examined in regard to PA adherence over time.[104] Adults who participated in PA for enjoyment, competence, or social interaction had significantly higher adherence rates than those who were motivated by fitness or appearance.[104]

Moreover, Dudley, Okely, and Pearson evaluated a school-based intervention tailored to the preferences of adolescent girls in Sydney, Australia.[53] All girls in the study reported low enjoyment of PA at baseline. The intervention provided the girls a variety of new PA options, based on formative research of what types of PA girls most enjoyed (e.g., yoga, pilates, swimming, tennis). The study effectively increased PA enjoyment, physical self-perceptions, and PA; and showed mediating effects of PA enjoyment on PA.[53] This study suggested that, regarding girls' PA behaviors over time, it is more important for interventions to foster girls' enjoyment for a variety of PA options, even if they are low-moderate intensity activities, rather than pushing girls to engage in higher intensity activities that they enjoy less, for the sake of the immediate health benefits.[53] In contrast to the earlier studies, Schneider and Cooper described PA enjoyment playing a different role.[105] PA enjoyment was found to have moderating effects

on girls' responses to a PA promotion intervention. Girls with low PA enjoyment at baseline increased their PA from pre- to post-intervention, but girls with high PA enjoyment at baseline reported no change in their PA from pre- to post-intervention.[105]

More research is needed to clarify the role of PA enjoyment, especially as it relates to the social and physical environments and PA among early adolescent girls. Doing so stands to help families, schools, and communities address inactivity among girls in a manner, 1) that is tailored to sub-groups of girls at highest risk for inactivity and 2) that has sustained effects as the girls age into adulthood.

Chapter 3: Theoretical Guidance

Two theories provided guidance for this study: the Socio-Ecological Model of Health Behavior and the Social-Cognitive Theory. The Socio-Ecological Model proposes that public health problems, like inactivity among early adolescent girls, are influenced by factors from multiple levels of the model and thus are more effectively prevented or treated with multi-level interventions.[55] The Socio-Ecological Model includes five levels: individual (e.g., cognitions, affect, demographic characteristics), interpersonal (e.g., interactions with others), institutional (e.g., school), community (e.g., neighborhood), and societal (e.g., widespread norms and policies).[55] In the case of this study, an Aim 1 hypothesis is that PA among girls is influenced by their social (friends/family = interpersonal level; school climate regarding teachers and boys = interpersonal and institutional level) and physical (neighborhood = community level) environments, in part, through PA enjoyment (a cognition/affect = individual level). An Aim 2 hypothesis is that the pathways in Aim 1 will vary by demographic characteristics (race/ethnicity, SES, body fat percentage = individual level) of the girls (See Figure 3.1). For this study, the demographic characteristics are considered individual level variables. Race/ethnicity, SES, and body fat percentage could arguably be a part of all of the levels because they are individual characteristics that have strong societal meanings and repercussions that can permeate the lives and behaviors of girls on all five levels.[106] Figure 3.1 illustrates the level of the Socio-Ecological Model of Health Behavior with which each of the variables in the conceptual framework corresponds.

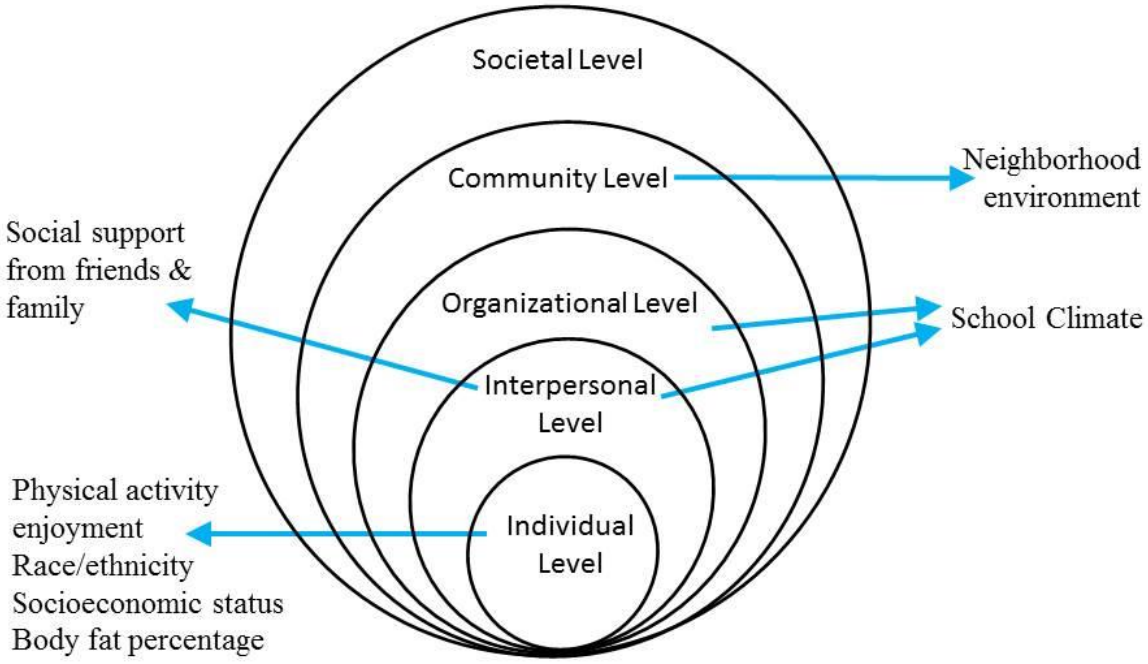

Figure 3.1 Study Variables and the Socio-Ecological Model of Health Behavior

Bandura's Social-Cognitive Theory (SCT) informed which TAAG variables were selected for the various levels Socio-Ecological Model as well as how they interact.[54] Bandura conceptualized the SCT to be "important constructs to understand and intervene in health behavior" (p.168).[55] Bandura's Social Cognitive Theory, a behavioral learning theory, proposes that individuals primarily learn to perform a behavior (e.g., PA) by observing others perform the behavior through vicarious learning and reinforcement.[54] The theory also explains the influence of the environment on how the individual processes what she observes, learns, and ultimately whether or not she performs the behavior.[54] Figure 3.2 illustrates the study variables from the conceptual framework with their corresponding SCT concept: person, environment, and behavior.

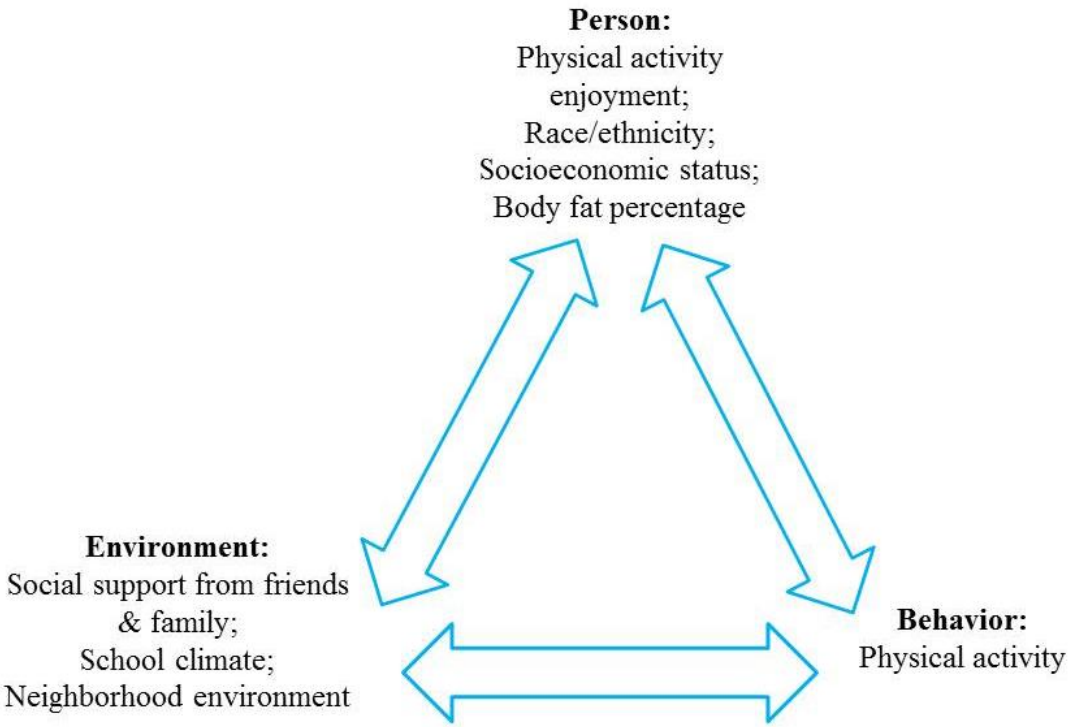

Figure 3.2 Study Variables and the Social-Cognitive Theory

The SCT is the most highly used and recommended theory in the literature on PA among early adolescent girls.[107,108] In a review of PA interventions for Hispanic girls and women, the SCT was the most commonly cited theoretical base for the interventions, though the review points out that all of the interventions addressed individual level determinants of the SCT and none of them addressed environmental determinants.[108] For future research on PA among Hispanic girls and women, the author of the review recommended addressing the school environment and social networks, in addition to the individual influences.[108] Similarly, a systematic review of obesity prevention interventions for early adolescent girls found that ineffective interventions tended to alter the environment and the individual separately and/or focused completely on one setting (i.e., school and not home) without addressing the other settings in which girls live and

interact.[109] Kesten and colleagues recommended addressing a social environment that includes school, family, and community settings.[109] Lastly, Dudley, Okely, and Pearson's study on early adolescent girls from low SES backgrounds, designed their PA intervention based on the SCT.[53] A major aim of the intervention was to increase the girls' PA enjoyment in order to increase their PA. The study saw a greater increase in PA enjoyment and less of a decline in PA among girls in the intervention group, compared with the control group.[53]

The multi-level influences on behavior explained in both the Social-Ecological Model of Health Behavior and the SCT, provided direction regarding the selection of social and physical environments as potential contributors to PA enjoyment, and in turn, PA of early adolescent girls (See Table 3.1). The presence of PA enjoyment in the SCT, a rare variable among health behavior theories, along with the PA intervention literature aimed at adolescent girls further informed this study's conceptual model with PA enjoyment as a partial mediator in the pathways from the social and physical environments to PA of early adolescent girls. Table 3.1 illustrates the selected study variables, including PA enjoyment, and their related SCT construct or constructs.

Table 3.1 Study Variables and their Related Social Cognitive Theory Constructs

Study Variable	**Related Social Cognitive Theory Construct(s)**	**Glanz, Rimer, & Lewis Definitions (p. 169)[55] in the Context of Early Adolescent Girls**
Physical Activity	Behavior	• A desired outcome of a Social Cognitive Theory intervention would be to increase a girl's physical activity or maintain her current level of physical activity.
Physical Activity Enjoyment	Reinforcements	• A positive or negative experience related to a behavior that increases or decreases the likelihood that a girl will repeat the behavior.
Social Support from Friends	Observational Learning Reinforcements	• A girl learns about a particular behavior by watching others perform the behavior. • A positive or negative experience related to a behavior that increases or decreases the likelihood that a girl will repeat the behavior.
Social Support from Family	Observational Learning Reinforcements	• A girl learns about a particular behavior by watching others perform the behavior. • A positive or negative experience related to a behavior that increases or decreases the likelihood that a girl will repeat the behavior.
School Climate	Situation	• A girl's perception of her surroundings
Neighborhood Environment	Environment Situation	• Things that influence a girl's behavior that derive from outside of herself • A girl's perception of her surroundings

Chapter 4: Methods

4.1 Sample Description

TAAG is the largest, most diverse U.S. study to date, focused on the PA of early adolescent girls. The two-arm group randomized study tested the effectiveness of school and community-based programs at lessening the decline in PA among early adolescent girls.[16] Assessments included three cross-sectional measures; one of 6th graders in spring 2003 (baseline), one of 8th graders in spring 2005, and one of 8th graders in spring 2006.[110] Aims 1 and 2 in this study were assessed by secondary analyses of the baseline data from 2003 (including in-person measurements of body fat percentage and responses from the self-report Student Questionnaire). Baseline data were selected for analysis because they do not include any of the potential effects of the TAAG intervention and sixth grade captures the central age for girls transitioning into adolescence from childhood (12 years old).[35]

Even though the data were collected over a decade ago, there is little reason to believe that the pathways to PA enjoyment have changed in the past 12 years. Strengths of the dataset outweigh this limitation, for example; the study sampled from five regions of the country and is large enough to test for differences across sub-groups of girls (e.g., low and middle/upper SES). The study variables are measured by generally well-validated scales, and the scale used to measure PA enjoyment is an improvement from other studies on PA enjoyment that only used a single question (i.e., do you enjoy PA?).[42,111]

TAAG was a high-quality study, supported by Cooperative Agreements from the National Heart, Lung, and Blood Institute and a PI from each of six field centers (University of Arizona, University of Maryland, University of Minnesota, University of South Carolina, San Diego State University, and Tulane University).[17] Each of the six field centers recruited six local middle schools (6^{th}-8^{th} grade; N=36 schools total).[110] Schools were selected to ensure that racial minorities represented at least 25 % of the sample. Sixty girls were randomly selected from each school to participate in each round of the assessments. Ineligible girls included those who did not speak English or were unable to exercise due to a medical condition.[110] At baseline assessment there were 2,160 sixth grade girls invited. In total, 1,721 parental consents and girls' assents to participate were collected (80 % consent rate) and all of those girls participated in the baseline evaluation measures.[49] The necessary steps to obtain access to the TAAG data, including IRB approval from Washington University in St. Louis and approval from the National Heart, Lung, and Blood Institute for data sharing were completed in June 2014.

4.2 Review of Measures and Variables

Aim 1 examines the role of PA enjoyment in the pathways from four social (social support from friends, social support from family, school climate) and physical (neighborhood) environment variables to PA of early adolescent girls. Table 4.1 shows measurement details for the hypothesized endogenous variables (PA and PA enjoyment) and exogenous variables (social and physical environments). Details on the demographic variables are discussed following Table 4.1. In Aim 2, the three demographic variables (race/ethnicity, SES, and body fat percentage) are tested for their moderating effects on the pathways from the social and physical environments to PA. All variables, except PA and body fat percentage, were assessed in the self-report Student

Questionnaire in the spring of 2003. PA was objectively collected by accelerometer counts. The necessary measurements for calculating body fat percentage were collected by trained researchers.

Table 4.1 Measures for TAAG Analyses[62]

Variable	Operational-ization	Alpha	Factorial Validity	Level of Measure-ment	Measure Details
Endogenous Variables					
PA	Mean minutes of moderate to vigorous-intensity movement over 6 days	N/A	N/A	Continuous	Computer Sciences Applications uniaxial accelerometers[112,113] • Worn on the hip continuously for 6 days, except when asleep or in water • Mean minutes, over 6 days, registered counts ≥1500/half minute (lower end of moderate PA threshold)[113,114] • Count threshold was decided by calibrating against girls' VO_2 output during a range of activities
PA Enjoy-ment	Positive feelings toward PA[66]	0.86[52]	Good model fit[90]	Continuous (scale range 6-30)	Adapted Physical Activity Enjoyment Scale [102] • Reverse code 7 negatively worded items (e.g., When I am active I feel bored; When I am active it's no fun) • 5-point Likert scale (agree a lot to disagree a lot)
Exogenous Variables					
Social Support from Friends	Gesture or encouragement from peers that facilitates engagement in PA[90]	0.75[90]	Accept-able model fit[68]	Continuous (scale range 3-15)	Amherst Study social support from friends scale[34] • 4 questions on how often a peer provides gestures of social support for PA during a typical week (e.g., How often do your friends do physical activities or play sports with you?) • 5-point Likert scale responses (none to every day)
Social Support from Family	Gesture or encouragement from people in one's household that facilitates engagement in PA[90]	0.81[90]	Accept-able model fit[52]	Continuous (scale range 4-20)	Amherst Study social support from family scale[34] • 4 questions on how often a household member provides gestures of social support for PA during a typical week (e.g., How often has a member of your household encouraged you to do physical activities or play sports?) • 5-point Likert scale responses (none to every day)
School Climate	Perceived attitudes, beliefs, and behaviors of	0.61[101]	Good model fit[95]	Continuous (scale range 6-30)	Modified GRAD Study school climate scale[115,116]

	teachers and boys at school related to girls' PA[95]				• 6 statements (e.g., In my school, boys stare too much at girls who are being physically active). • 5-point Likert scale (disagree a lot to agree a lot)
Neigh-borhood Charact-eristics	Perceived built environment, safety, and aesthetic conditions related to PA of the area around one's home[97]	0.78[97]	Unknown	Continuous (scale range 10-50)	A combination of the Amherst Study and Survey of Neighborhood, Life Satisfaction, and Physical Activity- neighborhood environment scale[97,117] • 10 statements describing neighborhood built environment, safety, and aesthetic characteristics (e.g., There are sidewalks on most of the streets in my neighborhood) • 5-point Likert scale (disagree a lot to agree a lot)

Note. PA: Physical activity; Unknown reliability indicates an opportunity for this study to contribute to the knowledge base

The moderating variables include race/ethnicity, socioeconomic status (SES), and body fat percentage. Race or ethnicity of the girl was assessed by asking whether the girl thought of herself as Hispanic, Mexican American, or of Spanish origin and, then, to indicate her race/ethnicity (all that apply) from a list of Caucasian (White, non-Hispanic), Black, Hispanic, Asian/Pacific Islander, American Indian, and Other.[16,118] Consistent with other studies based on the TAAG data, this study examines Aim 2 (see Analysis Plan) by three categories of race/ethnicity including Caucasian (White, non-Hispanic), Non-Hispanic Black, and Hispanic.[16,50]

SES was assessed, by the proxy measure of receipt of free or reduced-price lunch.[119] There is precedent for measuring SES through this primarily household income-based proxy.[3,17] In the measure, the girl was asked to indicate whether or not she "gets free or low-cost lunches at school?" Response options included yes, no, and don't know. The 'don't know' category in the

proposed analyses were dropped and SES was treated as a dichotomous variable (i.e., low and middle/upper SES).

Body fat percentage was measured by assessing height without shoes to the nearest 0.1cm, using a portable stadiometer; weight to the nearest 0.1 kg, using a digital scale (Seca 880); and triceps skinfold thickness on the right arm to the nearest 0.1 mm.[114] These measurements (in addition to BMI [body mass in kg divided by height in m^2] and weights for ethnicity [Non-Hispanic Black = 1; 0 = Other] and age [birthdate] of the girl) were entered into the following equation, created purposely for estimating body fat percentage in adolescent girls:[120] body fat percentage = 1.09617 (BMI) + 2.01320 (triceps skinfolds) – 0.03740 (triceps skinfolds^2) – 0.37363 (age) – 2.96995 (race/ethnicity contrast) – 11.57041.

Body fat percentage was transformed from a continuous variable into a dichotomous variable for Aim 2 analyses. There are no documented ideal healthy body fat percentages for early adolescent girls because they are still growing. The closest established range for healthy body fat percentage is 16 to 24 percent among women age 20 to 29 years old.[121] The American College of Sports Medicine has loosely defined healthy body fat percentage for teenage girls as a range that straddles the population average (e.g., 22 to 25 percent).[122] The dichotomous variable in this study includes ≤23 and >23 to reflect the mean body fat percentage of 12 to 15 year old girls between 1999 and 2004.[123]

4.3 Analyses

SPSS[124] was used for data management, univariate and bivariate analyses; and Mplus[125] was used for confirmatory factor analyses (CFA) and structural equation modeling (SEM). Structural equation modeling has a number of advantages over multiple regression techniques. For example, SEM can estimate the inter-relations between variables rather than assume they are independent, and can estimate all associations simultaneously. Structural equation modeling can include latent error terms to estimate the effects of omitted variables and measurement error.[126] Including estimates of measurement error increases one's confidence in the conclusions about the relative influence of factors affecting PA enjoyment. The standard maximum-likelihood (ML) and maximum-likelihood robust (MLR) estimators were used; the former is most appropriate for non-skewed distributions, continuous variables, and relatively low percentages of missing values and the latter necessary for calculating chi-square scaling correction factors for model comparison (Aim 2).[127] Recommended criteria for determining good fit was used.[128–130] Overall model fit was assessed with several fit indices including a non-significant ($p>0.05$) WLSMV chi-square value (χ^2); Comparative Fit Index (CFI) value greater than or equal to 0.95; a Root Mean Square Error of Approximation (RMSEA) value of 0.05 or less and its associated 90% confidence interval.

In addition to running descriptive analyses (e.g., frequency, mean, standard deviation, skew, kurtosis, minimum, maximum, Pearson chi-square difference test) on the variables and sample characteristics, preliminary analyses included CFA on each of the latent variables (PA enjoyment, school climate, social support from friends, social support from family, and neighborhood environment). CFAs were performed on each latent variable prior to testing the

proposed research aims, to obtain the most parsimonious and well-fitting models of the data. The CFAs were guided by theory[75], other studies that have conducted exploratory factor analyses or CFAs on the same measures[90,95,102], and model modification indices. To confirm the consistency of the CFA models, one half of the sample was randomly selected (i.e. split-half analyses).[131–133] This half was considered the developmental sample and was used to build the CFAs and to make any necessary model modifications. In the full sample, the final CFA models were re-run to ensure that the fit indices remained acceptable.

The final CFA models were then used in the Aim 1 model that tested PA enjoyment as a mediating variable in the pathways from the social and physical environments to PA (Hypotheses 1 & 2). Both direct (i.e., from the social and environmental variables to PA) and indirect (i.e., from the social and environmental variables to PA through PA enjoyment) pathways were tested. Mplus uses the traditional Delta method of estimating standard errors for indirect effects to determine the statistical significance of proposed mediators. Bootstrapping techniques were also used to obtain confidence intervals for specific parameters of interest.

Multiple group comparisons were conducted on the final model from Aim 1 to evaluate whether the indirect and direct pathways from social and physical environments to PA through PA enjoyment differed by race, SES, and body fat percentage of early adolescent girls (Aim 2, Hypotheses 3 & 4). Models were compared by group in a recommended systematic and hierarchical fashion by first running each model unconstrained (all pathways free to vary), followed by constraining the gamma (i.e., pathway estimate from PA enjoyment to PA) by setting it equal across demographic groups.[106,134] The model fit information for the constrained

model was statistically compared to the model fit of the unconstrained model using the Satorra-Bentler scaled chi-square difference test.[71,135] If the chi-square difference test for the two models was significant (p-value <0.05), the constrained model is rejected and the unconstrained model is accepted. In this case, the finding would indicate differences in the gamma pathway by demographic group, since the pathways cannot be held constant across groups without significantly decreasing fit. If the chi-square difference test for the two models was not significant, another model with an additional pathway (e.g., a beta pathway) set equal across demographic groups is constrained to be equal and this model's fit is compared with the previous unconstrained model, again using the chi-square difference test. This process is repeated until one of two results occurs. All pathways in the model could be set equal across demographic groups and the model fit remains non-significantly different from the initial unconstrained model, in which case one accepts the *most* constrained model as the final model and infers that there is no significant variance in model fit by the demographic groups. The other scenario is if a chi-square difference test shows significant decrement in fit from the initial unconstrained model, in which case one rejects the most constrained model and accepts the *next* most constrained model that does not result in a significant decrement in fit. When paths cannot be constrained to be equal across groups, moderation is assumed. All model fit comparison calculations were conducted in Microsoft Excel 2013.[136]

4.3.1 Power Analysis

There are no standard strategies for assessing power for SEM. Studies have found that a sample of 200 is generally necessary for SEM and having larger samples contributes negligible benefits to the results.[131–133] The TAAG dataset is far larger than the necessary sample size for SEM analyses,

which presents benefits and drawbacks. Having a larger sample size allowed for the split half analyses (N=860 in one half of the sample) to confirm consistency of model findings. The Aim 1 mediation model and Aim 2 group comparisons were made in 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 SEM analyses is that the chi^2 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 will be prioritized in evaluating the results (e.g., CFI, RMSEA). Small differences in multi-group models may produce significant moderator effects of small practical value, so both statistical and practical significance were considered in interpreting the results.

Chapter 5: Results

5.1 Descriptive & Preliminary Results

The demographic characteristics of the study sample (N=1,721) are described in Table 5.1. All of the girls in the sample are in the 6th grade. The mean age of the sample is 11.95 years (standard deviation=0.48; minimum=10.62, maximum=14.59). The mean body fat percentage of the sample is 28.05 percent (standard deviation=9.16; minimum=5.83, maximum=51.32), which is above the U.S. national average (23 percent).

Table 5.1 Demographic Characteristics of the 1721 6th Grade Girls

Demographic Characteristic	**N(valid percent)**
Race/Ethnicity	
Hispanic	380 (26.0)
Non-Hispanic Black	326 (22.3)
Non-Hispanic White	759 (51.8)
Missing[a]	257
Total	1721
Receipt of Free/Reduced-Price Lunch (socioeconomic status proxy)	
No	791 (53.3)
Yes	694 (46.7)
Missing[b]	236
Total	1721
Body Fat Percentage	
≤23	560 (33.2)
>23	1129 (66.8)
Missing	32
Total	1721

[a] The missing consists of 257 girls who reported a race/ethnicity of Non-Hispanic other.
[b] The missing consists of 14 girls who did not respond and 222 girls who reported that they did not know if they received free or reduced-price lunch or not.

The Pearson chi-square (χ^2) test of difference was used to identify statistically significant differences between the observed and expected distributions among the three demographic characteristic variables (See Table 5.2). Observed and expected distributions of body fat percentage by receipt of free/reduced-price lunch (an SES proxy) were not significantly different

(χ^2=0.53, p=0.82). There were significant differences between observed and expected distributions by body fat percentage and race/ethnicity (χ^2=13.90, p=0.00; Hispanic girls are more highly represented in the >23 body fat percentage group; Non-Hispanic Black and Non-Hispanic White girls are more highly represented in the ≤23 body fat percentage group). There were also significant differences between observed and expected distributions by receipt of free/reduced-price lunch and race/ethnicity (χ^2=223.66, p=0.00; Hispanic and Non-Hispanic Black girls are more highly represented in the group that receives free/reduced-price lunch; Non-Hispanic White girls are more highly represented in the group that does not receive free/reduced-price lunch).

Table 5.2 Bivariate Relationships among Demographic Variables

	Receipt of Free/Reduced-Price Lunch		Body Fat Percentage	
	No	Yes	≤23	>23
	Observed N (Expected N)			
Race/Ethnicity				
Hispanic	130(181.9)	207(155.1)	98(126.2)	275(246.8)
Non-Hispanic Black	82(160.3)	215(136.7)	125(109.3)	198(213.7)
Non-Hispanic White	469(338.9)	159(289.1)	264(251.5)	479(491.5)
Body Fat Percentage dichotomized				
≤23	253(250.9)	217(219.1)	-	-
>23	526(528.1)	463(460.9)		

Note. Pearson chi-square tests were used to statistically compare observed and expected frequencies

Table 5.3 includes the univariate distributions of the final items and variables included in this study after preliminary confirmatory factor analyses (See Appendix A). No items in the study showed skewness greater than an absolute value of two. Only two items within the latent factor of PA enjoyment showed a kurtosis greater than an absolute value of two (items 3 and 6 within PA enjoyment).[137] No items had missing responses that made up more than 10% of the total responses.

Table 5.3 Distributions of the Final Study Items and Variables

Variables and Items	N (N Missing)	Mean (SD)	Variance	Skewness (SE)	Kurtosis	Min	Max
Physical Activity							
Average daily minutes of moderate-to-vigorous physical activity	1721 (0)	23.91 (0.28)	146.00	1.29 (0.06)	2.42 (0.12)	2.61	87.78
Physical Activity Enjoyment (removed items 4 & 5)							
1. When I am active I feel bored	1718 (3)	1.78 (1.16)	1.34	1.38 (0.06)	0.80 (0.12)	1	5
2. When I am active I dislike it	1712 (9)	1.66 (1.02)	1.04	1.56 (0.06)	1.63 (0.12)	1	5
3. When I am active it's no fun at all	1715 (6)	1.51 (0.98)	0.97	2.06 (0.06)	3.55 (0.12)	1	5
6. When I am active it's not at all interesting	1699 (22)	1.55 (0.98)	0.96	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)	1.96 (1.24)	1.54	1.10 (0.06)	0.03 (0.12)	1	5
School climate (factors: teachers and boys; removed item 5)							
1. In my school PE teachers think boy should be more active than girls (teachers)	1715 (6)	2.08 (1.30)	1.70	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)	2.04 (1.23)	1.51	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)	2.89 (1.44)	2.08	0.04 (0.06)	-1.34 (0.12)	1	5
5. In my school being active around boys makes me uncomfortable(boys)	1708 (13)	2.27 (1.38)	1.90	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)	2.93 (1.45)	2.11	0.04 (0.06)	-1.34 (0.12)	1	5
Social support (factors: family and friends; removed item 1)							
2. How often do family members encourage you to do PA(family)	1672 (49)	3.39 (1.14)	1.31	-0.37 (0.06)	-0.47 (0.12)	1	5
3. How often do family members do the activity with you (family)	1663 (58)	3.03 (1.08)	1.16	-0.15 (0.06)	-0.30 (0.12)	1	5
4. How often do family members do they provide transport to a place of recreation (family)	1661 (60)	3.51 (1.16)	1.34	-0.46 (0.06)	-0.36 (0.12)	1	5
5. How often do family members watch you participate in activity (family)	1661 (60)	3.36 (1.17)	1.37	-0.40 (0.06)	-0.44 (0.12)	1	5

6. How often do family members tell you, you are doing well in activities (family)	1665 (56)	3.68 (1.21)	1.46	-0.63 (0.06)	-0.45 (0.12)	1	5
7. How often do your friends encourage you to do the activity (friends)	1679 (42)	2.80 (1.15)	1.33	-0.04 (0.06)	-0.59 (0.12)	1	5
8. How often do your friends do the activity with you (friends)	1679 (42)	3.31 (1.11)	1.24	-0.39 (0.06)	-0.24 (0.12)	1	5
9. How often do your friends tell you, you are doing well in activities (friends)	1663 (58)	3.08 (1.24)	1.54	-0.19 (0.06)	-0.74 (0.12)	1	5
Neighborhood environment (removed items 6 & 7)							
1. There are many places I like to go within walking distance of home	1716 (5)	3.60 (1.33)	1.76	-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)	2.71	-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)	2.53	-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)	1.61	-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)	1.46	-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)	1.77	-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)	1.70	-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)	2.05	-0.34 (0.06)	-1.23 (0.12)	1	5

Note: All percentages are valid percentages; SD: Standard deviation; SE: Standard error

Appendix A outlines the details of building measurement models and conducting confirmatory factor analyses of each of the latent variables (PA enjoyment, school climate, social support from friends, social support from family, and neighborhood environment). Table 5.4 presents the final models and fit indices in the full sample. The final models for PA enjoyment and social support both had moderately good fit. Both models had significant chi-square values indicating poor model fit, but also had other fit indices that indicated good model fit. School Climate had

excellent model fit across all fit indices; whereas neighborhood environment had fair model fit, with several fit indices close to the good model fit guidelines, but not within the cut-offs.

Table 5.4 Final Confirmatory Factor Models and Fit Indices of Latent Variables

Variable: Final Model Description	**# Items (# of factors)**	**χ^2(df)**	***P* value**	**CFI**	**RMSEA**	**CI**	**Factor & item covariance**	**Factor Loadings**
PA Enjoyment: without items 4 & 5; with covariance between items 6 & 7	5(1)	26.59(4)	0.00	0.99	0.06	0.04-0.08	item 6 with 7=0.16	0.69-0.81
School Climate: 2 factors (teachers and boys); without item 3; with covariance between items 4& 5	5(2)	7.51(3)	0.06	1.00	0.03	0.00-0.06	factor= 0.47 item 4 with 5= -0.33	Teachers: 0.77-0.90 Boys: 0.62-0.73
Social Support: 2 factors (friends and family); without item 1; with covariance for cross-factor similarities in item content between items 2 & 5; 3 & 6; 4 & 9	8(2)	181.69(16)	0.00	0.96	0.08	0.07-0.09	factor= 0.65 item 2&5= 0.18 item 3&6= 0.16 item 4&9= 0.23	Friends: 0.65 -0.73 Family: 0.54-0.79
Neighborhood Environment: without items 6 & 7; with covariance based on Evenson and colleagues' domains[138] between items 4, 5, 8 & 10; 2 & 3	8(1)	118.03(13)	0.00	0.94	0.07	0.06-0.08	item 4 with 5=0.17 item 4 with 8= -0.07 item 4 with 10=0.02 item 5 with 8=0.02 item 5 with 10=0.04 item 8 with 10=0.06 item 2 with 3=0.2	0.40-0.55

Note. χ2: WLSMV 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 ≤0.05 or less than its associated 90% confidence interval); CI: Confidence interval

5.2 Aim 1 Results

The model fit results of the Aim 1 model included a significant WLSMV chi-square value (χ^2 (292, N=1721) = 947.73 p < .001) indicating poor model fit, but all other fit statistics including CFI=0.95, and RMSEA=0.04 (90% CI=0.03, 0.04) suggested good model fit. Table 5.5 shows the direct and indirect pathways found in the Aim 1 model. Figure 5.1 visually displays the Aim 1 model results. There were no indirect effects on PA through PA enjoyment for any of the social or physical environment variables. To PA, there were significant direct effects only from social support from friends. To 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 lost significance when included in the full Aim 1 model. The overall Aim 1 model accounts for 15 percent of the variance (R^2=0.151) of PA enjoyment and only 2.5 percent of the variance of PA (R^2=0.025).

Table 5.5 Aim 1 Indirect and Direct Pathways to Physical Activity of Early Adolescent Girls

Structural paths	***p*-value for path significance**	**Standardized β**	**SE**
Aim 1 indirect effects			
Teachers → PA enjoyment → PA	0.80	<0.01	0.152
Boys → PA enjoyment → PA	0.80	<0.01	0.138
Social support from friends → PA enjoyment → PA	0.84	<0.01	0.134
Social support from family → PA enjoyment →PA	0.80	<0.01	0.219
Neighborhood → PA enjoyment → PA	0.81	<0.01	0.187
Aim 1 direct effects			
PA enjoyment → PA	0.79	0.01	1.223
Teachers → PA	0.21	-0.04	0.894
Boys → PA	0.16	-0.05	0.875
Social support from friends → PA	<0.001***	0.15	1.579
Social support from family → PA	0.64	0.02	1.700
Neighborhood → PA	0.94	0.01	1.742
Teachers → PA enjoyment	<0.001***	0.15	0.029
Boys → PA enjoyment	<0.001***	0.14	0.027
Social support from friends → PA enjoyment	0.10	0.08	0.051
Social support from family → PA enjoyment	<0.01**	0.15	0.056
Neighborhood →PA enjoyment	0.01*	0.10	0.056
Significant Factor Covariances			
Teachers with boys	<0.001***	0.45	0.042
Boys with social support from family	<0.001***	0.15	0.024
Social support from friends with social support from family	<0.001***	0.65	0.025
Social support from friends with neighborhood	<0.001***	0.40	0.022
Social support from family with neighborhood	<0.001***	0.44	0.022

Note. SE: standard error; PA: physical activity
*significant p<0.05; **significant p<0.01; ***significant p<0.001

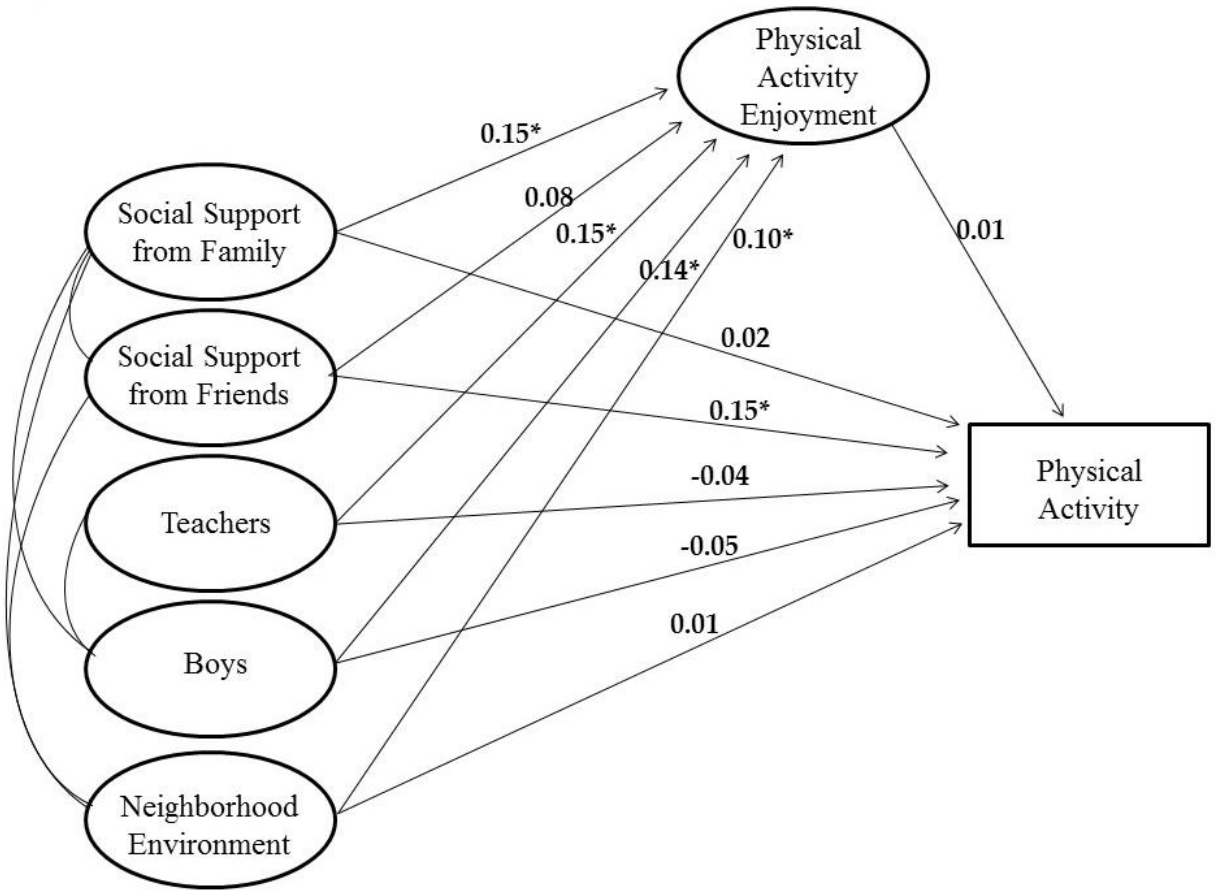

Figure 5.1 Aim 1 Model Results

5.3 Aim 2 Results

Aim 2 examined group comparisons, by race/ethnicity, SES, and body fat percentage, of the indirect and direct pathways from the social and physical environments to PA through PA enjoyment. None of the indirect pathways across any of the demographic groups were significantly different from the social and physical environment variables to PA through PA enjoyment. Table 5.6 displays the direct pathways from the social and physical environment variables to PA and PA enjoyment.

Several differences in direct pathways to PA and PA enjoyment are shown by race/ethnicity, SES, and body fat percentage. Among girls who are non-Hispanic black, the support from boys

was associated with PA and it was negatively associated. Only teacher support and the neighborhood environment were significantly, positively related PA enjoyment among girls who are non-Hispanic black. Among girls who are Hispanic, none of the variables were associated with PA, but support from boys, family, and a supportive neighborhood were positively related to PA enjoyment. Among girls who are non-Hispanic white, social support from friends was related to PA, while support from boys and family were positively associated with PA enjoyment. Among girls who receive free or reduced-price lunch (low SES proxy), none of the variables were related to PA, but teacher support and a supportive neighborhood were positively associated with PA enjoyment. For girls who do not receive free or reduced-price lunch (middle/high SES proxy), social support from friends was positively related to PA, while support from teachers, boys, and family were positively related to PA enjoyment. Lastly, pathways in Aim 1 between girls who have a body fat percentage above the national mean and at or below the mean do not differ much. Social support from friends is related to PA among both groups. Support from teachers and family are positively related to PA enjoyment as well for both groups. However, only among girls with a higher body fat percentage, support from boys and a supportive neighborhood were positively associated with PA enjoyment.

Table 5.6 Aim 2 Direct Pathways to Physical Activity Enjoyment and Physical Activity of Early Adolescent Girls by Race/Ethnicity, Socioeconomic Status, and Body Fat Percentage

Structural paths	**Group**	***p*-value for path significance**	**Standardized β**	**SE**
Aim 2 by race/ethnicity				
PA enjoyment → PA	NH Black	0.34	-0.07	2.792
	Hispanic	0.60	-0.04	2.667
	NH White	0.55	0.03	1.619
Teachers → PA	NH Black	0.84	0.02	2.736
	Hispanic	0.80	-0.02	1.884
	NH White	0.39	-0.04	1.340
Boys → PA	NH Black	0.04*	-0.19	2.676
	Hispanic	0.16	-0.09	1.565
	NH White	0.58	-0.03	1.306
Social support from friends → PA	NH Black	0.07	0.20	3.953
	Hispanic	0.45	0.07	3.172

	NH White	<0.01**	0.20	2.173
Social support from family → PA	NH Black	0.20	-0.13	4.190
	Hispanic	0.97	<0.01	4.015
	NH White	0.57	0.03	2.393
Neighborhood → PA	NH Black	0.91	0.01	4.369
	Hispanic	0.05	0.13	3.004
	NH White	0.58	-0.03	2.341
Teachers → PA enjoyment	NH Black	0.01*	0.28	0.074
	Hispanic	0.15	0.10	0.055
	NH White	0.17	0.07	0.038
Boys → PA enjoyment	NH Black	0.17	-0.13	0.078
	Hispanic	0.03*	0.17	0.058
	NH White	<0.001***	0.25	0.042
Social support from friends → PA enjoyment	NH Black	0.54	0.06	0.109
	Hispanic	0.52	-0.06	0.112
	NH White	0.08	0.13	0.070
Social support from family → PA enjoyment	NH Black	0.38	0.10	0.133
	Hispanic	0.04*	0.21	0.133
	NH White	<0.01**	0.21	0.073
Neighborhood →PA Enjoyment	NH Black	0.02*	0.19	0.123
	Hispanic	0.05*	0.16	0.106
	NH White	0.76	-0.02	0.072
Aim 2 by receipt of free/reduced-price lunch (socioeconomic status proxy)				
PA enjoyment → PA	Yes	0.89	0.01	1.959
	No	0.19	-0.06	1.649
Teachers → PA	Yes	0.09	-0.09	1.537
	No	0.74	0.02	1.264
Boys → PA	Yes	0.17	-0.07	1.331
	No	0.86	-0.01	1.194
Social support from friends → PA	Yes	0.09	0.12	2.607
	No	<0.01**	0.21	2.318
Social support from family → PA	Yes	0.85	-0.01	3.019
	No	0.64	0.03	2.449
Neighborhood → PA	Yes	0.75	0.02	2.917
	No	0.48	-0.04	2.756
Teachers → PA enjoyment	Yes	<0.001***	0.22	0.044
	No	0.02*	0.12	0.038
Boys → PA enjoyment	Yes	0.13	0.08	0.041
	No	<0.01**	0.17	0.036
Social support from friends → PA enjoyment	Yes	0.40	0.06	0.081
	No	0.22	0.09	0.071
Social support from family → PA enjoyment	Yes	0.26	0.08	0.094
	No	<0.01**	0.20	0.076
Neighborhood →PA Enjoyment	Yes	<0.01**	0.21	0.094
	No	0.67	0.03	0.080
Aim 2 by body fat percentage				
PA enjoyment → PA	>23	0.66	0.02	1.297
	≤23	0.08	-0.12	2.634
Teachers → PA	>23	0.36	-0.04	1.051
	≤23	0.44	-0.05	1.721
Boys → PA	>23	0.18	-0.05	0.993
	≤23	0.64	-0.03	1.596

Social support from friends → PA	>23	0.03*	0.11	1.921
	≤23	<0.01**	0.26	2.893
Social support from family → PA	>23	0.72	0.02	1.949
	≤23	0.64	0.04	3.229
Neighborhood → PA	>23	0.39	0.04	1.871
	≤23	0.11	-0.11	3.909
Teachers → PA enjoyment	>23	<0.01**	0.12	0.034
	≤23	<0.01**	0.22	0.043
Boys → PA enjoyment	>23	<0.001***	0.18	0.035
	≤23	0.25	0.06	0.038
Social support from friends → PA enjoyment	>23	0.37	0.05	0.065
	≤23	0.08	0.14	0.073
Social support from family → PA enjoyment	>23	0.04*	0.11	0.066
	≤23	<0.01**	0.25	0.088
Neighborhood →PA Enjoyment	>23	<0.01**	0.16	0.068
	≤23	0.50	-0.04	0.087

Note. SE: standard error
*significant p<0.05; **significant p<0.01; ***significant p<0.001

Table 5.7 shows the fit of the full models by race/ethnicity, SES proxy, and body fat percentage as the gamma (PA enjoyment to PA) and beta (social and physical environment variables to PA enjoyment and PA) pathways are constrained. By race/ethnicity, model fit decreased when the pathway from boys to PA enjoyment was constrained to be equal across the three subgroups. The final model constrained all other paths to be equal across race/ethnicity subgroups and had good fit. By SES, the fully constrained model had good fit. This indicates no significant moderating effects by SES. By body fat percentage, only the path from PA enjoyment to PA could not be constrained to be equal across groups.

Table 5.7 Aim 2 Model Comparisons

Model Description	Model χ^2	Model df	df difference	*P* value of χ^2 difference	Conclusion
Race/Ethnicity					
Model 1 unconstrained	1717.82	956	-	-	-
Model 2 gamma constrained only	1718	958	2	0.91	Accepted
Model 3 gamma and all betas constrained	1755.53	978	22	0.02*	Rejected
Model 4 gamma and all betas constrained, except Boys → PA enjoyment	1747.62	976	20	0.07	Accepted, Final Model
Socioeconomic status proxy					
Model 1 unconstrained	1227.95	624	-	-	-
Model 2 gamma constrained only	1229.4	625	1	0.23	Accepted
Model 4 gamma and all betas constrained	1247.45	635	11	0.05	Accepted, Final Model
Body fat percentage					
Model 1 unconstrained	1164.14	624	-	-	-
Model 2 gamma constrained only	1169.18	625	1	0.02*	Rejected
Model 3 all betas constrained only	1180.33	634	10	0.09	Accepted, Final Model
Model 4 gamma and all betas constrained	1183.91	635	11	0.04*	Rejected

Note. χ^2: chi-square; df: degrees of freedom; accepted signifies a non-significant p-value of χ^2 difference between the unconstrained model 1 and the respective constrained model; rejected signifies a significant p-value of χ^2 difference between the unconstrained model 1 and the respective constrained model.
*significant $p<0.05$

Chapter 6: Summary & Implications for Practice, Policy, and Research

The field of public health looks to the objectives set out in Healthy People reports to guide its efforts in research, program, and policy work. The past three Healthy People reports (2000, 2010, and 2020) have made the reduction and elimination of health disparities in the U.S. an overarching priority.[139] Other key objectives of Healthy People 2020 include increasing PA, achieving healthy weight status, and decreasing the incidence of chronic diseases for all U.S. residents.[140] Among adolescents, reducing risky behaviors (e.g., smoking, unprotected sex, substance use) and improving mental health are priority objectives as well.[141] The premise of this study is well-aligned with all of the aforementioned priorities set forth by Healthy People 2020.

This study, which to the author's knowledge is the first of its kind, begins to lay the foundation for future research on 1) the role of PA enjoyment in the pathways to PA among early adolescent girls; 2) the direct pathways from the social and physical environments to PA enjoyment; and 3) how these pathways vary or remain consistent across sub-sets of girls at highest risk for inactivity. In the context of other studies on PA enjoyment and PA, the findings of this study can inform strategies and programs for increasing PA enjoyment and PA across all adolescent girls. The findings of this study also raise new research questions and implications for future research, programs, and practice.

Aim 1 examined PA enjoyment as a partial mediator of the effects of social and physical environments on PA among early adolescent girls. Inconsistent with the emerging PA intervention literature among early adolescent girls[40,51,53], this study found no evidence of mediation by PA enjoyment in the pathways from the social and physical environments to PA among the 1,721 sixth grade girls. Necessary for finding a mediating effect, there must be a direct relationship between PA enjoyment and PA, but such a relationship was not found in this sample. Other studies have found direct effects of PA enjoyment on PA among early adolescent girls.[51,142] The abbreviated measure of PA enjoyment used in the TAAG study could possibly contribute to these dissimilar findings. The fact that all of the latent variables were self-report, while PA was objectively measured, could also contribute to the lack of relationship between the two variables. For instance, previous studies have found a relationship between self-report measures of the environment and self-report PA among girls, but not objectively measured PA.[95,138] Very little variance was accounted for in the Aim 1 model related to PA (2.5%), which raises the question of why to include these variables, especially PA enjoyment, in the model. While the question is valid, the interest of this study was not so much in explaining the variance in PA, but examining the role of PA enjoyment in specific environmental ways that would be relevant to communities, schools, and families. These results are discussed next.

The second hypothesis related to Aim 1 predicted that peer influence (i.e., social support from friends and school climate related to boys) would have the strongest positive associations with PA enjoyment. This study found social support from friends to be the only environmental variable that was not associated with PA enjoyment; whereas school climate related to teachers and boys, social support from family, and neighborhood all had positive associations with PA

enjoyment. The findings from this study did, however, show that social support from friends produced different results compared with the other social and physical environment variables; it was the only variable related to PA and the only variable that was not related to PA enjoyment. Erickson's Theory of Psychosocial Development explained that 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.[56] Overall, the Aim 1 findings reflect an influence of a girls' surroundings on her PA enjoyment, but among the girls in this study sample, the social support of friends may be more relevant to PA than PA enjoyment.

Study Aim 2 went a step further and examined whether the Aim 1 pathways varied by girls' race/ethnicity, SES, and body fat percentage. Again, no evidence was found of PA enjoyment as a mediator in the pathways from the social and physical environments to PA after examining the model by the various demographic groups. When the full models were tested for moderation by the various demographic groups the only notable moderating effect was the influence from boys at school on PA enjoyment that varied by race/ethnicity. Though the estimates were small, support from boys at school was positively associated with PA enjoyment among girls who were Hispanic and girls who are non-Hispanic white, whereas there was no significant relationship among girls who were non-Hispanic black. Other studies have confirmed the influence of boys on PA among early adolescent girls, but the influence is generally negative, like the negative relationship found among girls who were non-Hispanic black in this sample.[50,80,143] This is the first study that has found that when boys are supportive of girls' PA, it has a positive influence on girls' PA enjoyment, at least among girls who are Hispanic and non-Hispanic white. Similarly, this is the first study to examine and find that girls of different racial/ethnic

backgrounds have different experiences or reactions to the support of boys at school. The influence of PA enjoyment on PA varied by body fat percentage according to the model comparisons, but the pathway was insignificant for both groups, thus not practically important. On the whole, these findings do not support the three hypotheses associated with Aim 2 that predicted significant moderation of model effects by race/ethnicity, SES, and body fat percentage. The lack of additional significant moderating effects by race/ethnicity, SES, and body fat percentage, when examined as a full model, means that the direct pathways described in the following paragraphs should be interpreted modestly, such that the differences identified merely suggest directions for further investigation.

There were several differences identified in the direct pathways to PA enjoyment and PA by demographic groups. One notable direct pathway to PA enjoyment was the consistent, small, positive influence of the neighborhood environment on PA enjoyment among all sub-sets of girls at highest risk for inactivity (i.e., girls of a racial/ethnic minority, from a low SES household, and/or with a body fat percentage above the national mean). This relationship was not found among the lower risk sub-sets of girls. Biddle and colleagues explained that effect sizes may be small in regard to the influence of the environment on youth's PA because more often than not the built environment is unsupportive of their PA; there is a lack of wide variability.[144] Not surprisingly, there are similarities between the pathways to PA enjoyment among girls from low SES households and girls who are of a minority race/ethnicity because of the disproportionate presence of girls of a minority race/ethnicity living in disadvantaged households. Likewise, girls who are Hispanic or non-Hispanic black and/or from low SES households tend to have higher body fat percentages than girls who are non-Hispanic white and/or from middle/upper SES

households.[145] This pattern of findings supports part of the Aim 2 hypothesis (2.2) that predicted stronger effects of the neighborhood environment among girls who live in low SES households compared with girls who live in middle/upper SES households. A potential explanation for this difference is that families who live in low SES households have fewer financial resources and are more likely to be single-parent households, compared with families of middle/upper SES households.[146,147] These families may have less flexible work schedules and may be less able to pick up their daughters from afterschool PA opportunities or afford to enroll them in organized PA programs. The neighborhood may be the only option for settings in which girls can be active that requires no additional resources from their parents, increasing its value related to PA enjoyment compared with other social environmental factors. Kuo and colleagues found that the most common contexts in which early adolescent girls engage in PA were the home and neighborhood.[73] Studies have shown that girls who live in low SES households tend to have poorer perceptions of their neighborhoods, than girls from middle/upper SES households.[57,91,92] Regardless, this study showed the positive effects of a supportive neighborhood environment on PA enjoyment among girls who live in low SES households. Gathering more specific information on girls' perceptions of the neighborhood environment and what can be done to make their neighborhoods feel more supportive of their PA would be a helpful next step for researchers, especially for identifying paths to promote PA enjoyment among girls at highest risk for inactivity. Accompanied by other studies, the consistent relationship between the neighborhood and girls' PA enjoyment among the girls at highest risk for inactivity lends support to community-level efforts to invest in the facilities, aesthetics, and safety of low SES neighborhoods and create PA opportunities around the home. For girls who live in walking distance from their school, policies and programs that enhance access to and improve the quality

of places for girls to engage in physical activity for transportation and recreation should be implemented. This includes Complete Streets policies, Safe Routes to School programs, and joint use agreements, or policies that allow free play on school grounds after school hours.[148,149] One study highlighted the great need for more Open Use Policies among middle schools. The study found that only 25 percent of the schools in which the TAAG participants were enrolled allowed for use of the school grounds after school hours and on weekends.[150]

Recalling the significant direct effects from social support from friends on PA found in Aim 1 among the full sample of girls, the Aim 2 results provided important insight to this finding. When examined by demographic group, this relationship between social support from friends and PA was only significant among girls who were non-Hispanic white or were from middle/upper SES households and not significant among girls of a minority race/ethnicity or from lower SES households (i.e., girls at highest risk for inactivity). Acknowledging the small path estimates, this finding supports the broader research that claims a "one size fits all" approach is not the most effective strategy across diverse populations.[144,151] In research, when diverse populations are treated as one group, the experiences of the majority are likely to mask the experiences of the minority, as they did in the aforementioned finding. The findings of this study and several reviews of PA literature on adolescent girls agree that there is a need for more research on sub-group specific pathways to PA enjoyment and PA in order to create tailored strategies that target the experiences of girls with the highest risk for inactivity.[37,144,151]

Across all demographic groups of girls in this sample, the present (though weak) direct effects of the social and physical environments on PA enjoyment support the theoretical posits of the

Socio-Ecological Model of Health Behavior and the Social Cognitive Theory relating to the interaction of an individual's affect and demographic characteristics with her social and physical environments.[54,55] However, in this sample, the effects of the individual and her environment on her behavior (i.e., PA) did not surface as the theories prescribed. Since the broader literature, especially intervention studies cite the importance of PA enjoyment in promoting PA among early adolescent girls, there remain many research questions to explore (e.g., How does PA enjoyment contribute to various domains (e.g., leisure, transport) within PA?; Is PA enjoyment moderated by other factors?; Might PA enjoyment predict PA only in certain cases?). Future research is also needed on the larger causal model that includes the role of PA enjoyment as it relates to PA, precursors to PA enjoyment, as well as the variables to which PA enjoyment is a precursor. Longitudinal research would be most helpful in unraveling this causal picture, not only in adolescence but into adulthood.

A review of PA intervention studies among Hispanic and non-Hispanic black adolescent girls calls for more interventions to make changes to the social and physical environment, in addition to individual-level changes, in order to see an increase in PA.[108] One change to the social environment, supported by findings from this study, includes training school teachers on how they can show support for girls' PA in order to facilitate the development of PA enjoyment among girls who are non-Hispanic black, live in low SES households, and/or have a higher body fat percentage. Specifically, one review recommends PE classes and PA programs that allow girls to choose from a variety of PA options, include their friends, and are not too intense or competitive.[143] Training teachers on how to foster supportive behaviors from boys at school is another recommendation for the promotion of PA enjoyment among Hispanic and non-Hispanic

white girls. This may mean having a strictly enforced school-wide policy against insults and discriminating or intimidating behaviors, especially relating to girls and their engagement in PA.

Other future research could include the development of an improved measure of PA enjoyment that is not limited to a negative orientation of the construct, which more accurately measures lack of PA enjoyment. The authors of the TAAG study did not make an adequate case for narrowing the scope of the construct, PA enjoyment, to the negative orientation alone. There are many reasons to capture the full spectrum of responses for the construct. The negative orientation limits variability of responses and makes the conceptualization of the construct to the items confusing. One recommendation is to replace the Likert scale response format with phrase completion. In phrase completion scales, the phrase introduces the concept and the response chosen (from an 11 point scale) completes the concept.[152] Phrase completion uses numbers to quantify the degree to which the underlying theoretical construct is present. The phrases can alternate introducing positively and negatively oriented aspects of the construct. Respondents choose their place along a numerical spectrum (e.g., Beginning of the phrase: When I am active I…Phrase completion: 0=never have fun to 10=always have fun) rather than choosing among sentiments (e.g., strongly agree to strongly disagree) as one would do with a Likert scale. Using phrase completion instead of a Likert scale could reduce bias and more accurately capture variance of response and foster richer data.

Moreover, all of the variables in this study have well-fitting measurement models, confirmed in this study and/or another study, except for neighborhood environment.[90,95,138] This study included confirmatory factor analyses on the neighborhood variable and respective items, with

guidance from the environmental domains defined by Evenson and colleagues.[138] The best fitting measurement model for neighborhood specified in this study was still not particularly well-fitting among this sample. There is opportunity to develop, or at least refine, a measure of the neighborhood environment based on the perceptions of early adolescent girls. The findings of this study related to the effects of the neighborhood environment on PA enjoyment among girls at highest risk for inactivity heightens the importance that additional attention be paid to the measurement of the neighborhood environment among diverse groups of early adolescent girls.

6.1 Recommendations

A "menu" of possible practice recommendations appear below. These recommendations are primarily for public health practitioners, school administrators, and others who would be selecting and/or designing programs aimed at increasing the PA and PA enjoyment of early adolescent girls:

- Recognize that a "one size fits all" program approach is likely not the most effective strategy across diverse populations of girls.
- Include friends in programs, especially among girls who are non-Hispanic white or from middle/upper SES households.
- Include boys at school in programs for girls who are Hispanic and non-Hispanic white, as long as the boys are encouraging and supportive of girls' PA.
- Implement a Safe Routes to School initiative or other program that provides opportunities for girls to comfortably walk in their neighborhoods, particularly in low SES neighborhoods and/or neighborhoods with large proportions of residents who are Hispanic or non-Hispanic black.

- Address both the social (e.g., support from family, friends, and teachers) and physical (e.g., neighborhood built environment characteristics) environments in programs.
- Provide trainings for school teachers, especially PE teachers, on how they can show support for girls' PA (e.g., allow girls to choose from a variety of PA options, include their friends, and are not too intense or competitive). This should be prioritized at schools in low SES neighborhoods and/or have a large proportion of students that are non-Hispanic black.
- Provide trainings for school teachers on how to foster supportive behaviors from boys, especially at schools that have large proportions of students that are Hispanic and/or non-Hispanic white.

The next recommendations apply primarily to "small p" policies, which are policies on the community, neighborhood, and school levels. These policy recommendations aim to promote PA and PA enjoyment among early adolescent girls:

- Enact and implement Complete Streets policies that invest in the improvement of the facilities, aesthetics, and safety particularly in low SES neighborhoods.
- Enact and implement Joint Use and Open Use agreements, particularly with middle schools in low SES neighborhoods, to allow free play on school grounds after school hours and on the weekends. Then, advertise the opportunity to use school facilities among community members (e.g., mentioned at Back to School Night).
- Enact and strictly enforce a school-wide policy against insults and discriminating or intimidating behaviors relating to girls and their engagement in PA.

Finally, the following recommendations are directed at researchers who study the understanding and promotion of PA and PA enjoyment among early adolescent girls. This list includes potential

research questions to explore and opportunities for future research based on gaps in the empirical literature relating to PA and PA enjoyment of early adolescent girls:

- How does PA enjoyment contribute to various domains (e.g., leisure, transport) within PA?
- Is PA enjoyment moderated by other factors (e.g., neighborhood built environment, parental PA engagement and attitudes)?
- Does PA enjoyment predict PA only in certain cases (e.g., only among girls who are already active, or only among girls who have higher levels of perceived physical competence (i.e., I am good at PA) or self-efficacy to perform PA)?
- Further explore girls' perceptions of the neighborhood environment and what can be done to make their neighborhoods feel more supportive of their PA, especially among girls who live in low SES households and/or are Hispanic and/or non-Hispanic black.
- Further examine sub-group specific pathways to PA enjoyment and PA (e.g., by age, race/ethnicity, SES, body fat percentage, urbanicity of where the girls live) in order to create tailored strategies that target the experiences of girls with the highest risk for inactivity.
- Conduct longitudinal studies on a larger causal model that includes the role of PA enjoyment as it relates to PA, precursors to PA enjoyment, as well as the variables to which PA enjoyment is a precursor.
- Improve the measurement of PA enjoyment by replacing the Likert scale response format with phrase completion.
- Develop, or at least refine, a measure of the neighborhood environment that includes the perceptions of early adolescent girls.

6.2 Limitations & Strengths

The cross-sectional nature of the baseline TAAG data cannot establish temporality of dependent and independent variables and thus, cannot test for causal relationships. The data are from 2003, but they are the only publically available dataset containing a measure of PA enjoyment among a diverse sample of early adolescent girls. There is also little reason to believe that the pathways to PA enjoyment have changed substantially over the past decade. The measures are primarily self-report, which are vulnerable to biases (e.g., recall, social desirability). Girls were recruited from six regions of the country, which raises concerns about group differences by region and the ability to pool across samples. However, Dishman and colleagues found no evidence of group differences by region for PA enjoyment and PA in the baseline data.[153] Also, body fat percentage was dichotomized by whether the girls had body fat percentages lower or higher than the national average (23%). This was done because the author was unable to find clear clinical cut-points of healthy and less healthy body fat percentages for early adolescent girls. Using other cut-points that may better reflect normal and overweight or obese for this variable may lead to different associations. Lastly, though PA enjoyment is measured by a well-validated scale among girls, and is an improvement from other public health studies on PA enjoyment that only used a single question, the scale is not ideal.[42,111]

The numerous strengths of this study outweigh these limitations. This study was the first to carry out the specified aims. Strengths of the dataset are that it samples from five regions of the U.S. and is large enough to test for differences across sub-groups of girls (e.g., race), imperative for Aim 2. The focus on PA enjoyment is a strength of the study because it is one of few determinants of PA that is a predictor of PA, not only in adolescence, but over time.[43,44] This

study is unique in that it focused solely on early adolescent girls (who are developmentally different from late adolescent girls[62]) and examined theoretically informed pathways to PA enjoyment and PA that are not understood. This study also begins to uncover potential reasons for the differences in PA enjoyment and PA seen by race, SES, and body fat percentage of girls.[49] To measure body composition, this study used a specially calculated body fat percentage measure that was developed for adolescent girls.[120] Unlike the body fat percentage calculations, body mass index (BMI; a commonly used measure of body composition) does not account for fat-free mass (e.g., muscle). Thus, muscular individuals with low body fat percentages could be mis-categorized as overweight if BMI is used as the body composition measure. The body fat percentage measure in this study is a more accurate measure of body composition than BMI. Lastly, using SEM to address Aims 1 and 2 is strength over traditional regression approaches, which cannot account for the intercorrelations between predictors, measurement error, and estimate all paths in a single model.

6.3 Conclusions

Framed in the context of other studies on PA enjoyment and PA, the findings of this study can inform strategies and programs for increasing PA enjoyment and PA among adolescent girls. For example, fostering social support from friends may be a priority strategy for PA promotion among girls who are non-Hispanic white. Building a supportive neighborhood environment and training teachers on how to facilitate a supportive school environment may be key factors for promoting PA enjoyment among sub-groups of girls at the highest risk for inactivity (e.g., Hispanic, non-Hispanic black, low SES, and/or above average body fat percentage).

Longitudinal research is needed to further explore the full causal model of pathways to PA enjoyment and PA by sub-groups of early adolescent girls.

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Appendix

Appendix A. Results of Confirmatory Factor Analyses on Latent Study Variables

Model name and number	# Items	# Factors	χ^2	df	P	CFI	RMSEA	CI (upper bound <1)	AIC	Factor covariance or item covariance	Factor Loadings	Notes
Variable: School Climate												
Climate 1	6	1	544.20	27	0.00	0.82	0.15	0.14 - 0.16	21767.44	N/A	0.55-0.74	poor fit
Climate 2 without item 3	5	1	231.47	5	0.00	0.81	0.23	0.20 - 0.25	14418.20	N/A	0.288 (#5 low)-0.91 (#2 high)	1 factor but without item 3; things stayed close to the same as Climate 1; RMSEA got worse, AIC & chi^2 got a little better
Climate 3 with 2 factors (teachers and boys) and without item 3	5	2	20.95	4	0.00	0.99	0.07	0.04 - 0.10	14209.68	0.48		Birnbaum (2005) suggested 2 factors & dropping item 3; better fit than Climate models 1&2 all around, but not great across the board; There were no modification index results that suggested

												cross factor correlations
Climate 4 with 2 factors (teachers and boys), without item 3, items 4&5 correlated errors	5	2	5.48	3	0.14	1.00	0.03	0.00 - 0.07	14196.21	0.48 item 4 with 5= -0.32	Teachers: 1=0.77 2=0.97 Boys: 4=0.71 5=0.63 6=0.61	Same model as Climate 3, but items 4 & 5 with correlated errors informed by modification index suggestion; all in all great fit.
Re-run in full sample: Climate 4 with 2 factors (teachers and boys), without item 3, items 4&5 correlated errors	5	2	7.51	3	0.06	1.00	0.03	0.00 - 0.06	27383.28	0.47 item 4 with 5= -0.33	Teachers: 1=0.77 2=0.90 Boys: 4=0.73 5=0.65 6=0.62	Everything stayed well fitting in the full sample.
Model name and number	**# Items**	**# Factors**	**χ^2**	**df**	**P (NS)**	**CFI (≥.95)**	**RMSEA (≤.05)**	**CI (upper bound <1)**	**AIC**	**Factor covariance or item covariance**	**Factor Loadings**	**Notes**
Variable: PA Enjoy												
Enjoy-ment 1	7	1	142.23	14	0.00	0.96	0.10	0.09 - 0.12	15517.63	N/A	0.61-0.83	Not terrible fit with1 factor, but not good; good, consistent factor loadings across items
Enjoy-ment 2 without item 4	6	1	76.65	9	0.00	0.97	0.09	0.07 - 0.11	13728.94	N/A	0.69-0.82	This model has no item covariances; Dishman (2010) said

(depressed)												drop item 4 (depressed, loading=0.75) because of kurtosis and most said strongly disagree. This model is slightly better than Enjoyment 1, but not a lot better.
Enjoyment 3 without item 4 (depressed) plus covariance of items 6&2 (not at all interesting & dislike it)	6	1	53.29	8	0.00	0.98	0.08	0.06 - 0.10	13707.58	item 2 with 6= -0.24	0.58-0.81	The modification index results of Enjoyment 2 suggest covariance of item 6&2 so I try that here. Slightly better fit than Enjoyment 2. Chi^2 is improved but still significant.
Enjoyment 4 without item 4 (depressed) or 5 (frustrates) (no item covariances)	5	1	31.64	5	0.00	0.99	0.08	0.05 - 0.10	11382.84	N/A	0.70-0.84	Dishman (2010) later in the article suggested dropping item 5 (loading=0.58, lowest loading) as well ("adj R2 was 0.94 for predicting a total enjoyment score from 4 items"p.83). Again, slight improvement, mostly in

												the chi^2 and not much else.
Enjoy-ment 5 without item 4 (depressed) or 5 (frustrates) and with covariance (items 7&6: rather be doing something else & not at all interesting)	5	1	10.15	4	0.04	1.00	0.04	0.01 - 0.07	11363.35	item 6 with 7=0.12	0.71-0.85	Modification index from Enjoyment 4 suggested covariance of items 6&7, so I try that here. This is actually good fit, though there is a fair amount done to it.
Re-run in full sample: Enjoy-ment 5 without item 4 or 5 and with covariance (items 7&6)	5	1	26.59	4	0.00	0.99	0.06	0.04 - 0.08	21760.89	item 6 with 7=0.16	0.69-0.81	Everything got slightly worse when re-run in the full model, but it's still pretty good fit. I also tried running the model without the item covariance and fit was worse.
Model name and number	**# Items**	**# Factors**	**χ^2**	**df**	**P (NS)**	**CFI (≥.95)**	**RMSEA (≤.05)**	**CI (upper bound <1)**	**AIC**	**Factor covariance or item covariance**	**Factor Loadings**	**Notes**
Variable: Social Support (SS)												

SS 1	9	1	544.20	27	0.00	0.82	0.15	0.14 - 0.16	21797.44	N/A	0.55-0.74	Poor fit across the board
SS 2 without item 1 (do you encourage your friends to do PA)	8	1	291.73	20	0.00	0.89	0.13	0.11 - 0.14	19497.01	N/A	0.55-0.74	Dishman (2010) suggested removing item 1 (item 1 loading=0.60-middle of range) because it is inconsistent with the other social support questions. Removing item 1 improved fit a little.
SS 3 with family & friends separate without item 1 (do you encourage your friends to do PA)	8	2	117.07	19	0.00	0.96	0.08	0.06 - 0.09	19324.35	0.71	Friends: 2=0.63 3=0.65 4=0.76 Family: 5=0.59 6=0.57 7=0.76 8=0.78 9=0.78	Having 2 factors did improve fit significantly compared to SS 2. The fit is pretty good.
SS 4 with covariances for cross-factor similarities in item content (i.e., specific words) (item 2&5; 3&6;4&9)	8	2	62.41	16	0.00	0.98	0.06	0.04 - 0.07	19275.69	0.68 item 2&5= 0.13 item 3&6= 0.18 item 4&9= 0.21	Friends: 2=0.64 3=0.64 4=0.75 Family: 5=0.59 6=0.56 7=0.77 8=0.80 9=0.77	This model is the same as SS 3 but this one accounts for content covariance across the factors that are based on source. This has pretty good fit. Chi^2, CFI and RMSEA are

without item 1 (2 & 5: friends & family encourage you to do PA) (3 & 6: friends & family do PA with you) (4&9: friends & family tell you you are doing well at PA)												slightly better than SS 3.
Re-run in full sample: SS 4 with covariance for cross-factor similarities in item content (i.e., specific words) (item 2&5; 3&6;4&9) without item 1	8	2	181.69	16	0.00	0.96	0.08	0.07 - 0.09	37434.46	0.65 item 2&5= 0.18 item 3&6= 0.16 item 4&9= 0.23	Friends: 2=0.65 3=0.65 4=0.73 Family: 5=0.59 6=0.54 7=0.73 8=0.79 9=0.78	Everything got slightly worse re-running it in the full model. Although everything is still pretty good.
SS 6 with Emotional & Instrumental factors without item 1	8	2	288.78	19	0.00	0.89	0.13	0.12 - 0.14	19496.06	1.04		Social Support Theory would support looking at the items based on the

												type of support provided; I got multiple errors in the output. Fit is worse than SS 3 & SS 2, and factor covar is greater than 1
Model name and number	**# Items**	**# Factors**	**χ^2**	**df**	**P (NS)**	**CFI (≥.95)**	**RMSEA (≤.05)**	**CI (upper bound <1)**	**AIC**	**Factor covariance or item covariance**	**Factor Loadings**	**Notes**
Variable: Neighbor-hood												
Neighbor-hood 1	10	1	374.40	35	0.00	0.73	0.10	0.10 - 0.11	29585.30	N/A	0.13 (item 6 & 7)- 0.58	Pretty poor fit across the board. 2 low loadings- items 6&7 (both safety questions)
Neighbor-hood 2 without items 6&7 (so much traffic makes it hard to walk & lot of crime)	8	1	114.03	20	0.00	0.90	0.07	0.06 - 0.09	23770.37	N/A	0.42- 0.57	This is model 1 just with items 6&7 removed for their very low loadings. Chi^2 and CFI improved a lot compared to model 1.
Neighbor-hood 3 without items 6&7 (so much traffic makes it	8	1	87.75	19	0.00	0.93	0.06	0.05 - 0.08	23746.09	item 2 with 3=0.19	0.41- 0.58	This model is the same as model 2 but added item covariance based on modification

hard to walk & lot of crime) and with covariance of items 2&3 (there are sidewalks & there are bicycle or walking trails)												index output between facilities items 2&3 (Evenson (2010) defined domains). Fit is better than model 2.
Neighbor-hood 4 without items 6&7 and item covariance based on Evenson's (2006) domains (items: 4,5,8 & 10; 2&3)	8	1	62.62	13	0.00	0.95	0.07	0.05 - 0.08	23732.95	Item 4 with 5=0.18 Item 4 with 8= -0.02 Item 4 with 10=0.08 Item 5 with 8=0.07 Item 5 with 10=0.07 Item 8 with 10=0.09 Item 2 with 3=0.18	0.36-0.58	Evenson (2006) used a longer version of NEWS- it shows that safety includes (items 4-8 & 10), aesthetics includes item 9, and facilities near home includes (items 2&3), and transportation (item 1). I can't run them as separate factors but I can have covariance of items within the same domain. Ended up with good CFI and slightly better chi^2, while RSMEA

												went .01 up and factor loadings for some items got slightly lower. There is probably more theoretical support for this one compared to Neighborhood 3 and they have very similar results.
Re-run in full sample: Neighbor-hood 4 without items 6&7 and item covariances based on Evenson's (2010)domains (items: 4,5,8 & 10; 2&3)	8	1	118.03	13	0.00	0.94	0.07	0.06 - 0.08	45843.42	Item 4 with 5=0.17 Item 4 with 8= -0.07 Item 4 with 10=0.02 Item 5 with 8=0.02 Item 5 with 10=0.04 Item 8 with 10=0.06 Item 2 with 3=0.2	0.40-0.55	Everything got slightly worse re-running the model in the full sample.