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Original Article

# Correlates of long-term physical activity adherence in women

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## Abstract

**Background:** Little is known about the factors that may influence women's adherence to moderate to vigorous physical activity (MVPA) using longitudinal data. The purpose of this study was to examine the correlates of long-term physical activity (PA) participation among women.

**Methods:** Female data from Waves I, III, and IV ( $n = 5381$ ) of the National Longitudinal Study of Adolescent to Adult Health (Add Health) were used for the analysis. The outcome of PA adherence was operationalized as (1) consistently physically active (at least 5 instances during the week) in both Waves III and IV (during adulthood), and (2) consistently not physically active or only physically active in either Wave III or IV. Predictor variables from Wave I (during adolescence) included race/ethnicity, PA level, self-perception of being physically fit, general health status, attempt to change weight, parents' income level, parents' education, well-being, depression, access to PA resources, days of physical education (PE), and grade level. Crude and adjusted logistic regression models were utilized to estimate the adjusted odds ratios (aOR) and 95% confidence intervals (95%CI) for the outcome variable.

**Results:** PA levels during adolescence significantly predicted PA adherence (aOR = 1.67, 95%CI 1.35–2.05). Additionally, wanting to lose weight (aOR = 1.49, 95%CI 1.20–1.85), using fitness center in the neighborhood (aOR = 1.28, 95%CI 1.04–1.58), and having 5 days of PE a week (aOR = 1.50, 95%CI 1.09–2.06) were significant predictors. Women who did not perceive being physically fit (aOR = 0.65, 95%CI 0.45–0.95) and Black, non-Hispanics (aOR = 0.59, 95%CI 0.43–0.81) were less likely to adhere to PA.

**Conclusion:** The findings suggested that physically active adolescents were more likely to become active adults. Future research should address interventions (e.g., PE program, community resources) that may promote lifetime PA in women, with the goal of decreasing morbidity and mortality.

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**Keywords:** Females; Longitudinal; Moderate to vigorous physical activity; Social ecological frameworks

## 1. Introduction

The proportion of children who are obese or overweight has significantly increased over the last decade.<sup>1</sup> In 2011–2012, 31.8% of children (95% confidence intervals (95%CI), 29.1%–34.7%) in the US aged 2–19 years were either overweight or obese, and 16.9% of the youth (95%CI, 14.9%–19.2%) were obese.<sup>2</sup> Rising rates of obesity have dangerous long-term effects since 40%–70% of obese children will become obese adults when they grow up.<sup>3</sup>

Sedentary activity is one of the major factors identified as contributing to the obesity crisis. Research has also revealed

numerous associations between physical activity (PA) and health outcomes. For example, PA can reduce risk of early death, cardiovascular disease, stroke, hypertension, type 2 diabetes, and depression and increase cognitive function.<sup>4,5</sup> While the public health significance of PA is well documented, a recent report showed that only 18.4% of adolescents meet current PA guidelines for aerobic activities; this is even lower for females at 11.4%.<sup>6</sup> Meanwhile, only 21% of U.S. adults participated in enough aerobic and muscle strengthening exercises to meet guidelines in 2011, with men more likely than women to meet these guidelines.<sup>6</sup> In addition, a previous study revealed that PA stability over 22 years from youth to adulthood was low and not significant, whereas body mass index (BMI) stability was moderately strong.<sup>7</sup> Specifically, only 16% of physically active youths became active adults and 83% of overweight youths remained overweight as adults, while 85% of overweight adults were not overweight youths.

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Research has suggested that participation in PA also declines across the lifespan and the sharpest decrease occurs during the transition from late adolescence to early adulthood.<sup>8</sup> Using Add Health data in Waves I and III, a study examined trends in achieving five or more sessions of moderate to vigorous physical activity (MVPA) per week across the transition period from adolescence to young adulthood.<sup>9</sup> Results showed that the majority of men (52.3%) and women (70.7%) did not achieve this amount of PA across both periods. Essentially, only very few (4.4%) among those who achieved five or more weekly sessions of MVPA continued to achieve these recommended amounts of PA. A prospective longitudinal study further indicated that women's PA significantly decreased from high school to college and suggested that the transition from high school to college is a critical time to promote PA among women.<sup>10</sup>

As highlighted in these reports, women are not only less likely to participate in PA compared to men but also less likely to consistently engage in PA over the years than men. Nonetheless, PA is especially important to women since it can influence future generations due to health status during pregnancy or modeling of behaviors to offspring.<sup>11,12</sup> In order to provide effective interventions for prompting PA, studies have been conducted to identify factors that influence women's PA participation. Much of the past research has used social ecological frameworks for a more comprehensive understanding of PA behavior. Such frameworks allow for the integration of the multifaceted influence of individual, social and policy, and environmental factors on participation in PA.<sup>13</sup>

A range of individual factors including demographic, biomedical, and psychological factors influence participation in PA for young women. Specifically, research has suggested that age, ethnicity/race, education, socio-economic status (SES), cardiovascular disease/cancer, BMI, self-reported health status, mental health/depression, attitude, self-efficacy, enjoyment, values, and beliefs can influence women's PA.<sup>14,15</sup> Social factors specifically among adolescent young women that influence PA include social support from peers, family status,<sup>16</sup> family cohesion, parent-child communication, and parent engagement.<sup>17</sup> Additionally, school-organized sports program and physical education (PE) are important factors in encouraging and sustaining PA behaviors.<sup>18,19</sup> Environmental factors include the physical environment, neighborhood design, and structural issues that influence women's decision to become physically active.<sup>20</sup> Moreover, previous studies have reported that landscape diversity, higher street connectivity, and lower crime are associated with women's PA participation.<sup>21</sup> A previous study also found that high crime level was significantly associated with a decrease in weekly MVPA among 17,766 U.S. adolescents enrolled in middle and high schools using Add Health data.<sup>22</sup>

Although we have known that aforementioned factors, alone or in combination, could impact women's decision about PA engagement, the majority of the literature evaluates PA across age groups using cross-sectional data or confines longitudinal data to short time windows.<sup>14–16,23,24</sup> Research on the topic of PA, particularly as it relates to factors that contribute to PA adherence in women, is scarce.<sup>25</sup> Furthermore, the limited literature is

mixed as to factors that are associated with women's PA adherence over time. White and colleagues<sup>25</sup> suggested that women's enjoyment, length of the PA bout, setting, self-efficacy, and program tailoring may be factors that influence women's adherence to PA.<sup>25</sup> In a longitudinal analysis, Hearst et al.<sup>24</sup> examined how factors are associated with MVPA among adolescents ( $n = 578$ , aged 10–16 years at baseline) from a social ecological model. They found that baseline MVPA and perceived barriers significantly predicted girls' MVPA at the 24-month follow-up. Additionally the results suggested that self-efficacy did not emerge as a significant predictor for girls in their sample (aged 10–16 years), although self-efficacy has been found to be the only consistently positively associated variable with MVPA changes among the youth.<sup>26</sup>

In summary, previous studies have suggested that the relationship between individual, social, and physical environmental factors and PA adherence in women has been inconclusive and studies longer than 2 years are needed because these factors may change over time.<sup>24,25</sup> Thus, the purpose of the present study was to explore the correlates of long-term PA adherence among women using nationally representative longitudinal data. The topic is salient as Healthy People 2020 aims to increase the proportion of adolescents and adults who meet current national PA guidelines for aerobic activities and for muscle-strengthening activities.<sup>27</sup> Findings have the potential to provide evidence-based strategies for future PA intervention or program design.

## 2. Methods

### 2.1. Study design and population

This study consisted of a secondary data analysis using data from Add Health. Add Health is a longitudinal study of a nationally representative cohort of adolescents that aims to identify social, behavioral, and biological linkages across the life course.<sup>28</sup> The study began in 1994 with adolescents in the 7th through 12th grades. A systematic sampling method was used to recruit 80 high schools that were representative of schools in the US with regard to region, urbanicity, size, type (e.g., zip code, public or private school) and ethnicity. Each high school identified a 7th grade feeder school, resulting in a total of 132 participating schools across 80 communities. After an initial in-school questionnaire, students were stratified by grade and sex. Subsequently, approximately 17 students from each stratum, for a total of about 200 adolescents per community school pairing, were randomly selected for an in-home interview. At Wave I a total of 20,745 adolescents were interviewed. There have been three subsequent Waves of interviews. The sample for this current study was derived from Waves I (1994–1995), III (2001–2002), and IV (2008–2009). Wave II (1996) data were not used for this analysis due to the time proximity of the measure of PA in Wave I and due to the amount of missing data at this wave.

In Wave I, 10,480 of the participants were women. Among them, 7038 women completed all three waves we are interested in and only 6682 women had sample weights available. Participants with missing information regarding PA, any covariates,

or survey weights were excluded from the analysis, leaving a final sample size of 5381. When assessing the missing data, it appeared that parental education and PE were the two predictors producing the most missing data. The majority of participants were White-non-Hispanics (67.9%). This study received exempt status from the University of South Florida Institutional Review Board.

## 2.2. Measures

### 2.2.1. PA outcome

PA level was assessed using six items each from Waves III and IV. The PA questions followed the following format: “In the past 7 days, how many times did you . . .” perform a specified type of PA. Types of activities included: bicycle, skateboard, dance, hike, hunt, yard work, roller blade, roller skate, downhill ski, snow board, racquet sports, and aerobics; strenuous team sports such as football, soccer, basketball, lacrosse, rugby, field hockey, or ice hockey; individual sports such as running, wrestling, swimming, cross-country skiing, cycle racing, or martial arts; and activities such as gymnastics, weight lifting, strength training, golf, fishing or bowling, softball or baseball. These activities are considered as MVPA with regard to intensity level. The participants then listed the number of times they participated in any of those activities in the last 7 days for each question. These numbers of activity participation instances were then summed to produce an overall number of instances the participants engaged in PA during that week.

Each participant was considered to have a high PA level if she reported doing any type of the activities five or more instances in the past 7 days at each wave, respectively. This method to operationalize PA using the Add Health dataset is consistent with other reports using these data.<sup>9,22</sup> The outcome of PA adherence was operationalized as (1) consistently physically active (at least 5 instances during the week) in both Waves III and IV, and (2) consistently not physically active or only physically active in either Wave III or IV.

### 2.2.2. Predictor variables

Predictor variables were selected based upon social ecological framework including three levels: (1) individual factors, (2) social/organizational factors, and (3) environmental factors. The variables ascertained for these levels were assessed during Wave I (Fig. 1) when participants were in the 7th–12th grades.

The first category was the individual level. The PA level at Wave I was measured and operationalized in the same fashion as Waves III and IV for the outcome variable. It was dichotomized as greater than or equal to five instances of activity and less than five instances of activity (referent category). Race/ethnicity was operationalized as White-non-Hispanic, Hispanic, Black-non-Hispanic, Asian, and other. The total parent income level was categorized as less than US \$20,000, between US \$20,000 and US \$59,000, and US \$60,000 or greater per year. The highest education level for either the mother or father was used as the parent education level, which was divided into less than high school, high school, some college, and college. The grade level (grades 7–12) of the participants in Wave I was also included as a predictor variable to control for differences in the measure of the baseline variables.

The participants were also asked to rate the extent to which they agree/disagree with the statement, “Do you consider yourself physically fit?” The responses were categorized as “strongly agree”, “agree”, “neither agree nor disagree”, and “disagree/strongly disagree”. The latter 2 categories of “disagree” and “strongly disagree” were combined due to low frequencies within these categories. Self-reported general health status was categorized as “excellent”, “very good”, “good”, and “fair/poor”. Due to the low frequencies in the Fair and Poor categories, these separate categories were combined. The depression score was a sum score derived from the Center for Epidemiologic Studies Depression (CES-D) scale.<sup>29</sup> It was measured on a Likert scale of 0 (*never or rarely*) to 3 (*most of the time or all the time*). The participants were asked by questions such as “bothered by things”, “could not shake off the blues”, *etc.* The well-being score was a sum score derived from questions regarding personality and was measured on a Likert scale of 1 (*not at all*) to 5 (*very much*).<sup>30</sup> Sample questions are “have a lot of good qualities” and “have a lot to be proud of”. Finally, the variable of wanting to change weight was measured by asking participants the question: “Are you trying to lose, gain, or stay the same weight?” The answers were categorized as trying to stay the same weight, trying to lose weight, trying to gain weight, or not trying to do anything about it.

The second category of variables was from the social/organizational level; these include school-related variables. The participants were asked if they were taught exercise in a school setting and were taught about the problems of being overweight

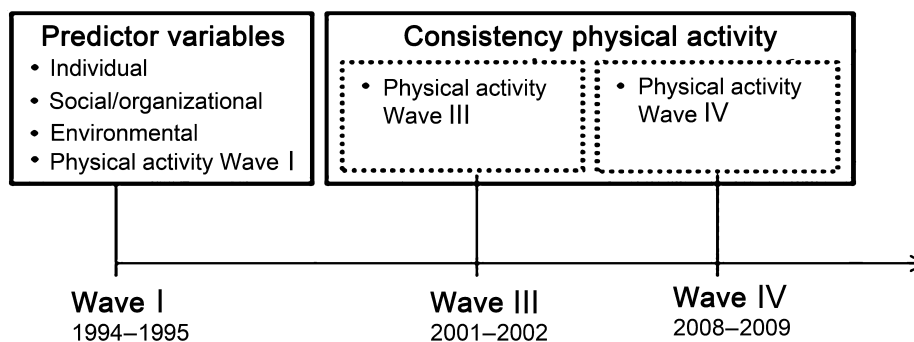


Fig. 1. Schematic of the study design and variables included.



in a school setting; these variables were dichotomized as yes or no. The number of days a week students had PE in school was categorized as 5 days, 1–4 days, 0 day, and no answer. Note, however, that many students reported not having PE (i.e., no answer) due to the time frame the questionnaire was administered (i.e., summer).

The third category of variables was the environmental level. The participants were asked if they used physical fitness centers in their neighborhood and felt safe in their neighborhood; these were dichotomized as yes or no.

### 2.2.3. Data analysis

Descriptive characteristics of the sample including PA frequencies and prevalence of structural predictors were examined. Chi-squared tests were used to test for differences in consistency of PA with predictor variables. A logistic regression model weighted for the survey weights in this sample was employed to investigate the association between consistent PA and predictor variables. Crude odds ratios (OR) and 95%CI for each variable and the outcome of PA were calculated. Adjusted OR (aOR) and 95%CI were determined and adjusted for each of the structural variables, individual race, and individual age. All analyses were conducted in SAS 9.3 (SAS Institute Inc., Cary, NC, USA).

## 3. Results

Table 1 suggests that the majority of participants in Wave I had parents with at least a high school education and income between US \$20,000 and US \$59,000 per year. There was an even distribution for grade levels for participants during Wave I. With regard to individual health characteristics, most participants agreed or strongly agreed that they were physically fit, reported either very good or excellent general health status, and wanted to lose weight. The mean depression and well-being scales for the population were 11.56 and 11.81, respectively. In Wave 1, more than half of participants were not engaged in MVPA for more than five instances in a week. Among the participants, 25.92% reported being consistently physically active.

Most participants were taught about exercise in school (92.66%), while fewer reported learning about the problems of being overweight (59.04%). Nearly 62.65% of the participants did not report being currently taught PE in school; however, this could be due to the fact that many participants were interviewed during the summer. Sixteen point zero two percent of the participants reported having 0 day of PE, 14.18% had 5 days of PE, and 7.15% had 1–4 days of PE. Finally, some participants reported not using a fitness center (17.19%) in their neighborhood and most of them felt safe in their neighborhood (89.85%).

OR were used to examine the independent association between each predictor variable and the odds of being consistently physically activity. Specifically, regarding the individual level predictors, being physically active during Wave I had two times the odds of being consistently physically active later in life. Black-non-Hispanics were less likely to be consistently physically active compared to White-non-Hispanics. Additionally, participants with parents who had higher incomes and high education sta-

tuses were more likely to be consistently physically active. However, variables for reducing the likelihood of being consistently physically active include: neither agreeing nor disagreeing to being physically fit, disagreeing or strongly disagreeing to being physically fit, agreeing to being physically fit, a “good” general health status, a “fair/poor” general health status, and wanting to lose weight.

In the crude logistic regression model, according to factors at the social/organization level, being taught PE for 5 days during the school week was significantly associated with being more likely to be consistently physically active later in life. Both predictors at the environmental level—using fitness center and feeling safe in the neighborhood—increased the likelihood of consistent PA.

Adjusted models included all predictor variables previously listed and adjusted odds ratios are reported (Table 2). Participants who were physically active in Wave I were more likely to be consistently physically active later in life (aOR = 1.67, 95%CI 1.36–2.05). Other individual level predictors for increasing the likelihood of being consistently physically active included: higher parent income; higher parent education; and wanting to lose weight in Wave I. In contrast, Black-non-Hispanics, participants who disagreed or strongly disagreed to being physically fit, and participants who neither agreed nor disagreed to being physically fit were less likely to remain consistently physically active.

At the social/organizational level, having PE five times a week remained statistically significant (aOR 1.48, 95%CI 1.09–2.02). At the environmental level, the effect of feeling safe in the neighborhood was attenuated to non-significant, but using a fitness center in the neighborhood remained statistically significant (aOR = 1.29, 95%CI 1.05–1.58).

## 4. Discussion

The purpose of the present study was to explore the correlates of long-term PA adherence among women using nationally representative longitudinal data. Previous studies revealed inconclusive findings regarding the consistency of PA levels across age groups.<sup>7,31</sup> Research has further indicated that there might be heterogeneous groups within these larger samples that limit firm conclusion to be made, and that there might be a specific determinant that influences the consistency of PA at different time periods.<sup>26,31</sup> Therefore, it is critical to identify factors that impact PA adherence in a relatively homogeneous group—teenage females (Wave I)—and that have significant life course implications for the individual and potential offspring.

### 4.1. Individual level

The findings suggest that physically active female adolescents are more likely to participate in PA when they become adults. This association has also been demonstrated in PA tracking studies. In a 21-year tracking study, Telama et al.<sup>32</sup> concluded that high levels of PA at ages 9–18, especially when continuous, significantly predicted high levels of adult PA. Likewise, Trudeau and colleagues<sup>19</sup> indicated that currently physically active females were more likely to have participated

Table 1

Survey-weighted proportions of predictor variables (Wave I) stratified by consistent physical activity level (Waves III/IV) among females from the National Longitudinal Study of Adolescent Health.

Predictor variables	Consistently active	Not consistently active	Total
<b>Individual level</b>			
Physical activity			
Yes (≥5 instances)	19.35 (0.92)	43.77 (1.15)	43.57 (1.04)
No (<5 instances)	6.52 (0.53)	30.37 (1.18)	56.43 (1.04)
Race/ethnicity			
White-non-Hispanic	19.26 (1.23)	48.60 (2.22)	67.86 (2.87)
Hispanic	2.60 (0.40)	8.55 (1.38)	11.15 (1.70)
Black-non-Hispanic	2.49 (0.40)	12.68 (1.81)	15.17 (2.09)
Asian	0.78 (0.22)	2.22 (0.54)	3.00 (0.72)
Other	0.74 (0.16)	2.08 (0.33)	2.82 (0.39)
Parent education			
Less than high school	2.21 (0.34)	8.49 (0.95)	10.69 (1.18)
High school	5.22 (0.45)	22.01 (1.21)	27.24 (1.28)
Some college	7.70 (0.53)	22.31 (0.95)	30.01 (1.13)
College	10.74 (0.91)	21.32 (1.40)	32.06 (2.01)
Parent income (per year)			
Less than US \$20,000	6.29 (0.47)	22.61 (1.42)	28.91 (1.56)
US \$20,000–US \$59,000	11.26 (0.62)	35.50 (1.16)	46.76 (1.31)
US \$60,000 or more	8.31 (0.71)	16.02 (1.18)	24.33 (1.65)
Grade			
7th	5.08 (0.71)	13.27 (1.60)	18.35 (2.16)
8th	4.33 (0.62)	12.29 (1.54)	16.63 (1.96)
9th	4.76 (0.54)	12.48 (0.99)	17.24 (1.31)
10th	4.16 (0.45)	13.15 (1.01)	17.31 (1.25)
11th	3.86 (0.41)	11.32 (0.91)	15.18 (1.10)
12th	3.67 (0.42)	11.62 (0.93)	15.29 (1.12)
Self-reported physically fit			
Strongly agree	6.19 (0.48)	12.62 (0.73)	18.81 (0.86)
Agree	12.34 (0.69)	33.57 (0.83)	45.91 (0.94)
Neither agree/disagree	4.84 (0.40)	17.25 (0.74)	22.10 (0.81)
Disagree or strongly disagree	2.49 (0.26)	10.70 (0.70)	13.18 (0.76)
Self-reported general health			
Excellent	7.50 (0.57)	17.09 (0.76)	24.59 (0.88)
Very good	11.35 (0.66)	29.63 (0.88)	41.00 (0.94)
Good	5.72 (0.43)	21.18 (0.90)	26.90 (0.92)
Fair/poor	1.29 (0.20)	6.24 (0.61)	7.51 (0.63)
Wanting to change weight			
Stay the same weight	8.36 (0.52)	26.34 (0.90)	34.69 (0.98)
Lose weight	13.16 (0.74)	33.56 (1.13)	46.72 (1.10)
Gain weight	1.31 (0.18)	5.47 (0.46)	6.78 (0.49)
Not trying to do anything	3.04 (0.36)	8.77 (0.65)	11.81 (0.82)
Depression (scale 0–30, mean)	11.23 (10.81, 11.64)	12.09 (11.84, 12.34)	11.56 (11.14, 11.98)
Well-being (scale 0–30, mean)	11.47 (11.28, 11.66)	11.85 (11.73, 11.96)	11.81 (11.63, 12.00)
<b>Social/organizational level</b>			
Physical education taught in school			
0 day	3.26 (0.37)	12.76 (1.23)	16.02 (1.39)
1–4 days	1.99 (0.35)	5.16 (0.76)	7.15 (0.99)
5 days	4.18 (0.48)	10.00 (1.02)	14.18 (1.30)
No answer	16.43 (1.02)	46.22 (1.45)	62.65 (1.95)
Taught exercise in school			
Yes	24.28 (1.02)	68.38 (1.11)	92.66 (0.76)
No	1.58 (0.26)	5.76 (0.70)	7.34 (0.76)
Taught problems of overweight in school			
Yes	15.59 (1.03)	43.45 (1.49)	59.04 (1.86)
No	10.28 (0.76)	30.69 (1.46)	40.96 (1.86)
<b>Environmental level</b>			
Fitness center in neighborhood			
Yes	5.47 (0.63)	11.72 (0.79)	17.19 (1.24)
No	20.39 (0.87)	62.42 (1.32)	82.81 (1.24)
Feeling safe in neighborhood			
Yes	23.85 (1.04)	66.01 (1.02)	89.85 (0.80)
No	2.02 (0.23)	8.13 (0.70)	10.15 (0.80)

Note: All the numbers are the percentages and standard error for the sample who have these characteristics among the whole sample and stratified by activity status, while the depression and well-being variables are presented as the means and 95% confidence intervals among the whole sample and stratified by activity status.

Table 2  
Logistic regression models predicting consistent physical activity level (Waves III and IV) for social environment, built environment, and individual predictors (Wave I) among females in the National Longitudinal Study of Adolescent Health ( $n = 5381$ ).

Predictor variables	Crude odds ratios (95%CI)	Adjusted odds ratios (95%CI)
<b>Individual level</b>		
Physical activity		
Yes ( $\geq 5$ instances)	<b>2.06 (1.69–2.52)</b>	<b>1.67 (1.36–2.05)</b>
No ( $< 5$ instances)	1.00 (referent)	1.00 (referent)
Race/ethnicity		
White-non-Hispanic	1.00 (referent)	1.00 (referent)
Hispanic	0.77 (0.58–1.01)	0.94 (0.69–1.28)
Black-non-Hispanic	<b>0.50 (0.37–0.67)</b>	<b>0.60 (0.44–0.82)</b>
Asian	0.89 (0.58–1.36)	0.87 (0.56–1.35)
Other	0.90 (0.57–1.41)	0.94 (0.63–1.43)
Parent income (per year)		
Less than US \$20,000	1.00 (referent)	1.00 (referent)
US \$20,000–US \$59,000	1.14 (0.93–1.40)	0.98 (0.78–1.22)
US \$60,000 or more	<b>1.86 (1.49–2.33)</b>	1.28 (0.98–1.67)
Parent education		
Less than high school	<b>1.00 (referent)</b>	1.00 (referent)
High school	0.91 (0.66–1.26)	0.82 (0.57–1.17)
Some college	1.33 (0.99–1.78)	1.12 (0.79–1.58)
College	<b>1.94 (1.46–2.56)</b>	1.40 (0.97–2.03)
Grade		
7th	1.00 (referent)	1.00 (referent)
8th	0.92 (0.67–1.26)	0.86 (0.62–1.19)
9th	1.00 (0.74–1.35)	0.98 (0.73–1.32)
10th	0.83 (0.62–1.10)	0.91 (0.70–1.20)
11th	0.89 (0.67–1.19)	1.03 (0.77–1.37)
12th	0.83 (0.61–1.11)	1.00 (0.75–1.32)
Self-reported physically fit		
Strongly agree	1.00 (referent)	1.00 (referent)
Agree	<b>0.75 (0.61–0.92)</b>	0.82 (0.64–1.05)
Neither agree/disagree	<b>0.57 (0.45–0.74)</b>	<b>0.71 (0.52–0.96)</b>
Disagree or strongly disagree	<b>0.47 (0.35–0.64)</b>	<b>0.65 (0.44–0.95)</b>
Self-reported general health		
Excellent	1.00 (referent)	1.00 (referent)
Very good	0.87 (0.70–1.09)	0.93 (0.73–1.20)
Good	<b>0.62 (0.48–0.79)</b>	0.78 (0.60–1.03)
Fair/poor	<b>0.47 (0.31–0.72)</b>	0.68 (0.44–1.07)
Depression (scale 0–30)	0.99 (0.97–1.00)	1 (0.99–1.02)
Well-being (scale 0–30)	0.97 (0.95–1.00)	1 (0.96–1.04)
Wanting to change weight		
Stay the same weight	1.00 (referent)	1.00 (referent)
Lose weight	<b>1.24 (1.02–1.50)</b>	<b>1.49 (1.20–1.85)</b>
Gain weight	0.76 (0.54–1.05)	1.03 (0.73–1.45)
Not trying to do anything	1.09 (0.84–1.42)	1.13 (0.86–1.48)
<b>Social/organizational level</b>		
Physical education taught in school		
0 day	1.00 (referent)	1.00 (referent)
1–4 days	1.51 (1.00–2.28)	1.36 (0.92–2.02)
5 days	<b>1.64 (1.19–2.25)</b>	<b>1.48 (1.09–2.02)</b>
No answer	<b>1.39 (1.08–1.80)</b>	1.29 (1.00–1.66)
Taught exercise in school		
Yes	1.29 (0.87–1.92)	1.11 (0.73–1.69)
No	1.00 (referent)	1.00 (referent)
Taught problems of overweight in school		
Yes	1.07 (0.88–1.31)	1.04 (0.84–1.29)
No	1.00 (referent)	1.00 (referent)
<b>Environmental level</b>		
Fitness center in neighborhood		
Yes	<b>1.43 (1.17–1.75)</b>	<b>1.29 (1.05–1.58)</b>
No	1.00 (referent)	1.00 (referent)
Feeling safe in neighborhood		
Yes	<b>1.46 (1.13–1.87)</b>	1.14 (0.86–1.50)
No	1.00 (referent)	1.00 (referent)

Note: Numbers in bold indicate statistical significance.  
Abbreviation: 95%CI = 95% confidence intervals.

in intense organized, non-organized, and recreational PA as children. A longitudinal analysis also suggested that females' baseline MVPA and age were positively and significantly associated with higher levels of MVPA at 24 months.<sup>24</sup> These findings suggest that health behaviors, such as PA participation, established early in life can become habituated and may influence their PA in future years.<sup>24</sup> Thus, PA programs and interventions that are specifically designed for children and adolescent girls may play a critical role in forming the foundations for subsequent active lifestyles in future years.

Regression analysis results also suggested that adolescent females' weight concern is a strong predictor of PA adherence. Specifically, "wanting to lose weight" appeared to be an important factor that motivates girls to continually participate in PA. On the one hand, PA has been considered as an important component of interventions to prevent weight gain and to enhance weight loss as well as to maintain weight.<sup>33</sup> On the other hand, losing weight is one of the most common reasons and a strong motivator for individuals to initiate exercise.<sup>34,35</sup> Additionally, research also suggested that "losing weight" and "looking better" are stronger motivators for obese than for normal-weight adolescents.<sup>36</sup> Findings from the present study further demonstrate that weight consciousness or losing weight is an important factor influencing long-term PA behaviors.

In addition to weight concerns, females' perception of being physically fit emerged as a significant predictor for PA adherence. Girls who were uncertain or had a neutral point of view of being physically fit were less likely to become physically active adults. Being physically fit is not only important for health; it reflects individuals' physical fitness level. For instance, maintaining a good physical fitness is impossible without regular exercise or PA. The relationship between physical self-perceptions and PA among school age children and adolescents has been shown in many studies.<sup>37,38</sup> Children and adolescents' perception of physical fitness was also found reliable and highly correlated to their measured fitness.<sup>39</sup> More importantly, research has revealed that adolescents' perception of their physical fitness is a crucial factor that impacts their intention toward future PA and subsequent PA patterns.<sup>38</sup> It might be reasonable to speculate that people who do not have an opinion about their physical fitness may not have the desire to consistently participate in PA. The present study's findings, therefore, might suggest that future interventions need to emphasize the importance of being physically fit and to enhance children and adolescents' awareness of their physical fitness level in order to promote PA adherence.

Moreover, this study found that Black-non-Hispanic females were also less likely to be consistently physically active. Given the fact that Black-non-Hispanic women are one of the least physically active subgroups of the population in the US<sup>40</sup> and only 17.3% of Black-non-Hispanic adults meet the 2008 Physical Activity Guideline,<sup>41</sup> it is imperative that future PA programs are tailored for Black-non-Hispanic adolescent females to improve their physical fitness with a hope to help them become physically active adults.

Finally, family SES was found to be associated with participants' continuous PA behavior. Specifically, regression analysis

suggested that participants with higher parent/family income and parental education were more likely to remain physically active. Previous research has suggested that higher family income or high socioeconomic status<sup>42</sup> and parental education were positively associated with adolescent young females' PA participation.<sup>43</sup> In addition, another study found strong estimated longitudinal effects of neighborhood SES deprivation on lower PA in Blacks but not Whites.<sup>44</sup> Our results add to a body of literature showing that PA adherence is also related to family SES; with high SES females more likely to participate in PA over time. Taken together, these findings suggest that girls from low SES backgrounds are at greater risk of the adoption and maintenance of PA behaviors.

#### 4.2. Social/organizational level

Results showed that having PE 5 times a week in middle and high schools was significantly correlated to women's long-term PA adherence. The association between PE and PA adherence was also found in previous studies. In their study, Trudeau et al.<sup>19</sup> found that children (female only, aged 10–12) who enrolled in the experimental program of enhanced PE (>3 times per week) were more likely to have a higher frequency of weekly PA when they became adults (aged 35) than those who had PE less than three times a week.

While National Association of Sport and Physical Education (NASPE), the Centers for Disease Control and Prevention (CDC), and the National Association of State Boards of Education (NASBE) all recommend a minimum of 225 min per week of PE for middle and high school students, only 7.9% of middle school and 2.1% of high schools provide the nationally recommended daily PE.<sup>45</sup> In addition, a recent survey showed that parents of students in high school were likely to report their children did not take PE at all (18%) than parents of children in kindergarten through grade 5 (2%).<sup>46</sup>

Although the intervention strategy of a median increase in time dedicated to PE by approximately 10% has been shown effective for PA promotion with diverse populations and in diverse settings,<sup>47</sup> PE classes, recess, and other PA breaks have decreased because many schools are increasing instructional time for science, mathematics, and reading in order to improve students' standards-based test scores.<sup>48</sup> The results of this study not only reiterate the importance of PE for PA adherence but also reinforce the need for daily PE for middle and high school students to foster long-term PA behavior.

#### 4.3. Environmental level

Surprisingly, the effect of feeling safe in the neighborhood was found to be a non-significant predictor of PA adherence. Previous research has found that safety concerns appear to be more influential in females than males with respect to PA participation.<sup>49</sup> However, as highlighted in previous studies, not all established correlates could be confirmed longitudinally.<sup>26</sup> It is possible that participants in Wave I moved to other neighborhood communities when they became adults. Thus, safety concerns about the neighborhood in childhood might not be relevant or might not predict their adulthood PA participation.

Our findings further indicate that having a fitness center nearby is important for long-term PA. If there is a fitness center in the neighborhood, adolescent females are more likely to exercise in the center, which might help them to develop sustainable healthy habits. Nevertheless, it might be too early to draw a conclusion with respect to the role of environmental factors in females' PA adherence as findings have not been consistent. For example, Gordon-Larsen et al.<sup>22</sup> suggested that adolescents' PA pattern was mostly associated with environmental factors such as community recreational center, while Hearst et al.<sup>24</sup> found no associations between environmental factors (e.g., neighborhood safety and ease of mobility) and adolescent females' PA changes. Further studies are warranted to explore important environmental level factors that may influence women's PA participation and adherence.

The above findings must be interpreted in light of noted study limitations. First, although variables examined in this study were selected based on the socio-ecological framework, some of the key factors may not have been included since this study utilized secondary data and was limited in the availability of those factors. Second, measures such as PA levels are self-reported. Objectively measured PA data are needed in future investigations. Third, in the data analysis, only women who completed all three Waves with survey weight available were included. Based on this, the final sample then came after removing predictors with missing data. As we analyzed the existing secondary data, these missing data and exclusions were not controlled by us and they were dropped in the analysis because they did not provide the needed information. Nonetheless, cautions should be taken when interpreting and generalizing the findings of this study. Finally, although we used longitudinal data, the participants' ages ranged from adolescents (7th graders) to adults in their early 30s. Therefore, the findings may not be generalized to other age groups of women.

## 5. Conclusion

Guided by the socio-ecological model, this study examined possible correlates of women's long-term PA adherence. Specifically, the present study has identified several individual, social/organizational, and environmental level factors that could impact women's sustainable PA behaviors. Previous research has suggested that the confounding effects of factors such as education, ethnicity, and socio-economic status made it difficult for optimal PA program design for women.<sup>25</sup> Therefore, these findings assist in highlighting factors across the social-ecological framework which need to be considered during the development of future intervention strategies that aim to support women's PA patterns across the life course.

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### Authors' contributions

HS conceived of the study and drafted the manuscript. CAV conceived of the study and helped to draft the manuscript as well as approved the final version. SBF conceived of the study and reviewed drafts as well as approved the final version. RD conceived of the study and reviewed drafts as well as approved the final version. ELT conceived of the study and performed analyses as well as helped to draft the manuscript. JB conceived of the study and performed analyses as well as helped to draft the manuscript. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

### Competing interests

None of the authors declare competing financial interests.

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