Patterns of Adolescent Moderate to Vigorous Physical Activity

Elizabeth Bates, Esmeralda Castro, & Zach Farley

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Abstract

Physical activity is beneficial for young people due to myriad benefits associated with enhanced physical and mental health: self-efficacy and mood, fostering normal growth and development, and reducing risk of chronic morbidity. For adolescents, achieving the recommended 60 minutes per day of moderate to vigorous physical activity (MVPA) is often an indicator of academic achievement. Despite these benefits, less than a quarter (24%) of school-aged youth meet recommendations. There are many ways in which a child may meet these recommendations, one of which is through time and resources available in the school setting (e.g., physical education classes, access to school physical activity resources, active transportation to and from school, etc.). However, not all schools provide these resources, and this may differ by the type of school attended (e.g., private, public, home, or other). Thus, patterns of PA may differ based upon these characteristics. Furthermore, there is evidence to suggest that time spent performing MVPA differs by individual characteristics such as body mass index (BMI) and sex (male/female). This study will investigate those patterns of physical activity among adolescents using Family Life, Activity, Sun, Health and Eating (FLASHE) study dataset from the National Cancer Institute. The driving questions of this study are: 1) How do patterns of MVPA for adolescents vary by sex after controlling for age and BMI?, and 2) Does minutes of MVPA performed weekly differ by the type of school attended (private, public, home, or other).

Introduction

It is well known that regular physical activity (PA) is associated with a myriad of physical and mental health benefits. These benefits may be proximal in time to the performance of PA, such as reduced anxiety-like feelings, lower blood pressure, and enhanced cognitive function, or they may be more distal, such as increased strength and cardio-respiratory fitness, decreased depression-like symptoms, and long-term reduction of blood pressure (Nebeling et al. 2017). Regular PA is especially important for school-aged children (6-17 years old); PA has been shown to foster normal growth and development, improve mood and sleep quality, and greatly reduce the risk for developing chronic disease(s) as an adult (Nebeling et al. 2017). Aside from these physiological benefits, physically active students tend to have better educational outcomes (e.g., better grades, enhanced cognitive performance, and decreased behavioral problems) when compared to their less-active peers (Rasberry et al. 2011). In addition, as both practice and research trends are leaning away from using body size, such as Body Mass Index (BMI), as a marker for physical health, they are turning to measures of regular physical activity and quantity of MVPA to indicate physical health (Hunger and Tomiyama 2015).

As outlined by the U.S. Department of Health and Human Services 2nd edition of the "Physical Activity Guidelines for Americans" (2018), the recommended daily dose of moderate- to vigorous-intensity physical activity (MVPA) for school-aged youth in the United States (US) is 60 minutes (US Department of Health 2018). Despite these recommendations regarding the benefits of meeting them, less than a quarter (24%) of school-aged children in the US achieve the recommended 60 minutes of MVPA a day (Child, Initiative, et al. 2017).

Many personal and environmental factors affect a child's ability to complete the recommended 60 minutes of MVPA a day. School-aged children spend nearly 3/4 of their weekdays in school, and yet there is a dearth of research addressing the association between school type (e.g. private, public, home-school) and health, specifically regarding physical activity.

The link between type of school attended and physical activity needs to be examined due to the potential for program development and policy changes related to physical education class requirements in school. This paper seeks to address this gap in the literature by examining both patterns and quantity of physical activity according to demographics and type of school attended.

This study will investigate those patterns of physical activity among adolescents and how various factors may be associated with MVPA during the week.

Research Questions

1. How do patterns of MVPA for adolescents vary by sex after controlling for age and BMI?
2. Does minutes of MVPA performed weekly differ by the type of school attended (private, public, home, or other)?

Hypotheses

1. Patterns of MVPA of adolescents will significantly vary by sex after controlling for age and BMI.
2. There will be a significant association between the type of school attended and the weekly minutes of MVPA performed by adolescents.

Methods

Data Source

This project uses data from the Family Life, Activity, Sun, Health and Eating (FLASHE) study. FLASHE data was collected through a cross-sectional design, using an internet-

based survey (Oh et al. 2017). Data collection occurred between April and October of 2014. The FLASHE study asked questions enabling researchers to examine correlates of cancer-related behaviors using behavioral measures of diet and physical activity, and other behaviors associated with cancer risk, such as sun-safety, sleep, and tobacco consumption. Sampling for the FLASHE study was drawn from a Consumer Opinion Panel and sampling design was intended to collect a representative sample reflective of demographics for the United States' general population (e.g., sex, education, income, age, region, household size). The conceptual model for the FLASHE study can be seen in Figure 1. It is important to note that data collection took place by sampling dyads of parent/caregiver-adolescent(ages 12-17). The FLASHE enrollment and design structure can be seen in Figure 2.

Figure 1: FLASHE Conceptual Model

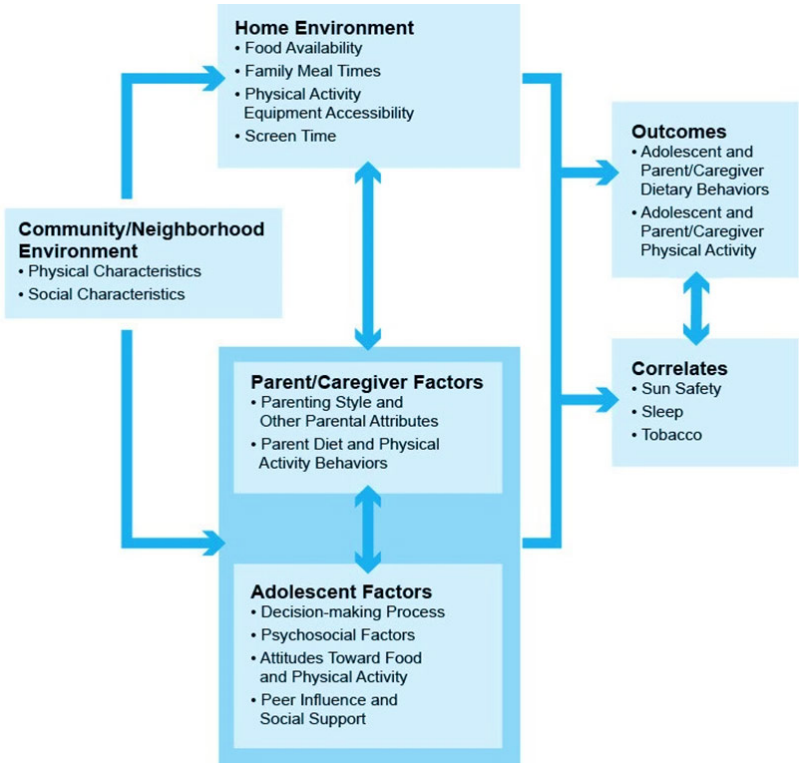
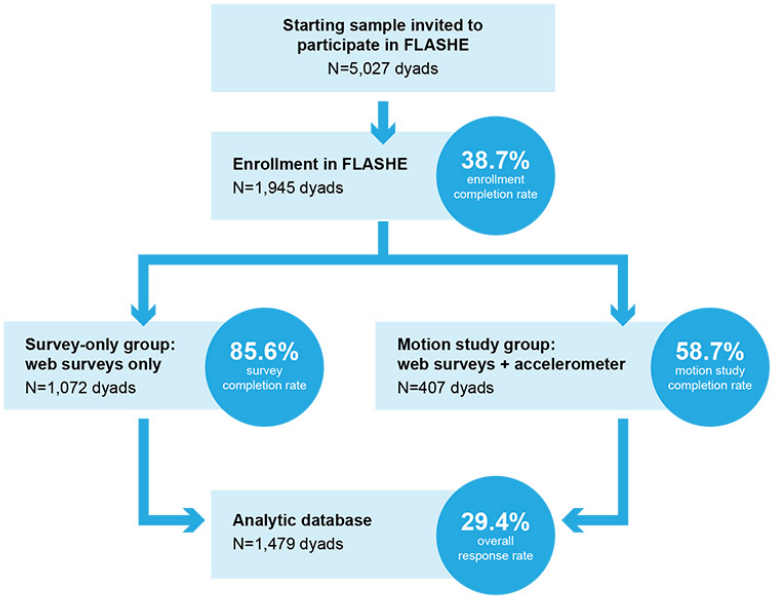


Figure2: FLASHE Enrollment and Design



Sample Selection

In our study, we aim to examine patterns of adolescent MVPA, including when and how much MVPA they perform, and to explore the association between adolescents' weekly minutes of MVPA and their sex, after adjusting for age and body mass index (BMI), as well as explore the association between adolescent's school type with their exercise patterns. For the purpose of this study, our final sample will be composed of teenagers (13-17 years old) who gave responses for all physical activity and demographic variables. This process and final sample size is explained in the following sections.

Statistical Analysis

Software Note

All analysis was conducted with the statistical software R (R Core Team 2021). The tidyverse package and others contained within the tidyverse package, such as ggplot2, dplyr, tidyr were used to clean, and visualize FLASHE data (Wickham et al. 2019), (Wickham 2016), (Wickham et al. 2021), (Wickham 2021). Additionally, the here, rio, and janitor packages were used to assist in importing and cleaning data (Müller 2020), (Chan et al. 2021), (Firke 2021). Also, the ggridges package was used to visualize data in a ridge plot (Wilke 2021). The gtsummary package was used to display tables in an easier to read and constant format (Sjoberg et al. 2021).

Demographic Characteristics

Descriptive statistics were performed to determine the distribution of study variables among participants and to check for skewness and kurtosis. All analysis was conducted with the statistical software R (R Core Team 2021).

Study Aim One

To address Study Aim 1, if there is an association between an adolescent's total MVPA and sex, after adjusting for age and BMI, a multiple regression was conducted. The dependent variable was an adolescent's total MVPA, which was calculated by adding the scores for 'MVPA during the weekday' and 'MVPA during the weekend.' The independent variable in the model was 'sex' (e.g., female and male). The variables included in the regression model that were controlled for were 'age' and 'BMI.' BMI was calculated from participants' self-reported height and weight with the equation: [weight (lb) / height (in) / height (in)] x 703 (Disease Control and Prevention 2014).

Study Aim Two

To address Study Aim 2, if there is an association between type of school attended and physical activity performed during the week, a one way ANOVA was conducted. The dependent variable was an adolescent's total MVPA, calculated as outlined above. The independent variables were the levels of 'school type' (e.g. public, private, home-school or another school type). For both study aims (1 and 2) figures were created to visualize the data and results.

Results

Participants

Table 1 displays the results of the descriptive characteristics of this sample. In total, there were 1192 in the final analysis. Participants were evenly distributed by age and sex, with a mean age of 14.9. Adolescents' MVPA varied from as low as 249.0852166875 to as high as 630.1628399375. Average weekly MVPA was 483.79. The majority of participants reported attending a public school 86.

Table 1. Descriptive Characteristics

Characteristic	**N = 1,192**[1]
Sex	
Female	599 (50%)
Male	593 (50%)
School Type	
Another kind of school	18 (1.5%)
Home-schooled	65 (5.5%)
Private school	84 (7.0%)
Public school	1,025 (86%)

Race/Ethnicity	
Hispanic	127 (11%)
Non-hispanic Black alone	195 (16%)
Non-hispanic White alone	775 (65%)
Other	95 (8.0%)
Age	
13 years old	280 (23%)
14 years old	223 (19%)
15 years old	241 (20%)
16 years old	286 (24%)
17 years old	162 (14%)

[1]n (%)

Patterns of Physical Activity by School Type

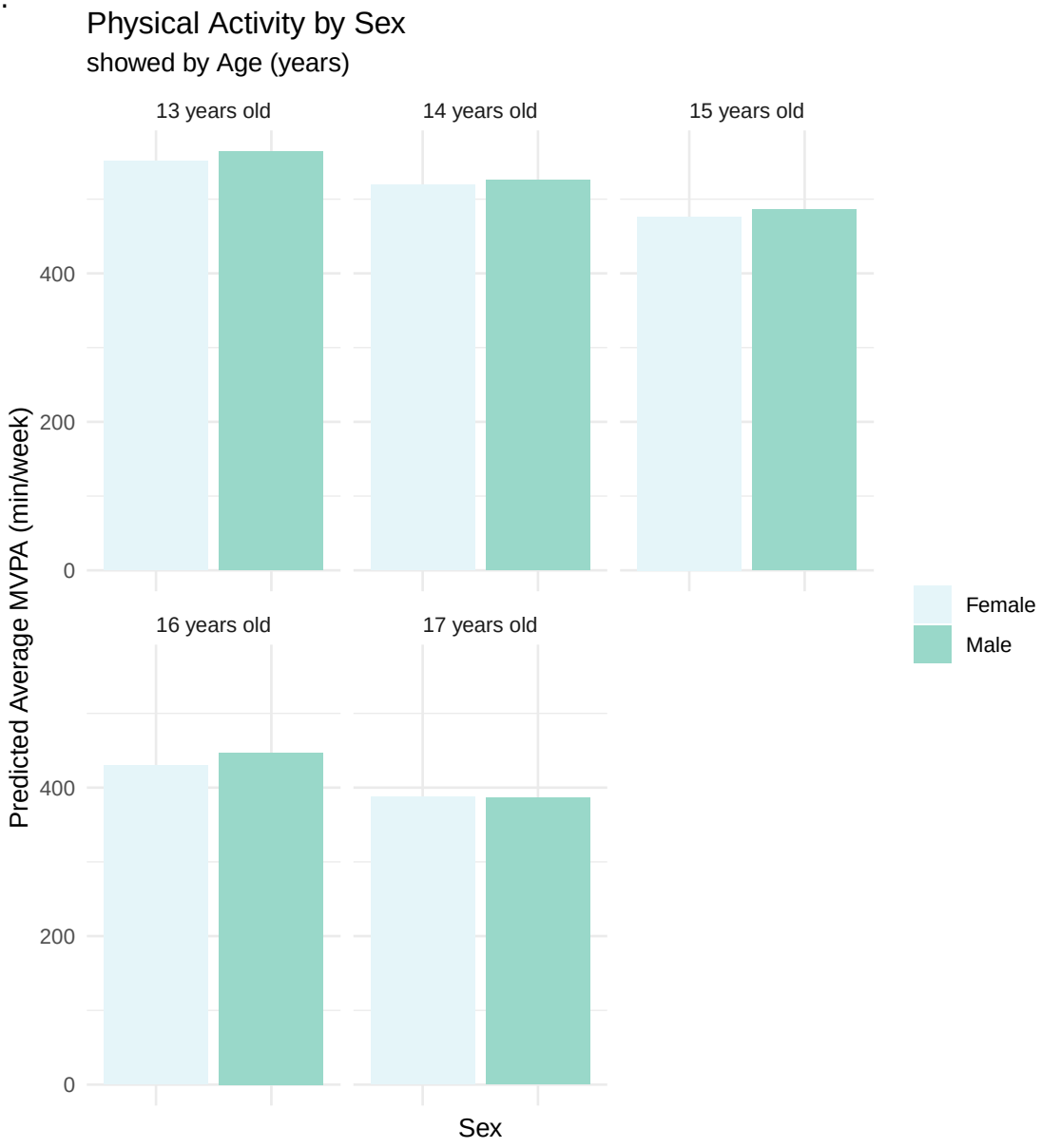
Table 2 displays the the amount of weekly MVPA across school types with respect to sex. Average BMI per school type is also included.

Participants' average MVPA by age, with respect to sex, is displayed in Figure 3. Patterns were observed with decreases in the predicted MVPA as participants got older. Male participants were predicted to obtain a higher average of MVPA than their female counterparts, but not by much more.

Table 2. Amount Physical Activity by School Type

School Type	Sex	Mean Age	Mean BMI	Average Weekly Minutes of MVPA	SD of Average Weekly Minutes of MVPA
Another kind of school	Female	15.00	22.05	477.85	74.75
Another kind of school	Male	14.89	25.07	452.54	75.14
Home-schooled	Female	14.87	21.91	472.39	76.45
Home-schooled	Male	14.83	21.75	477.86	91.38
Private school	Female	14.54	21.90	491.65	71.75
Private school	Male	15.08	22.44	489.21	68.67
Public school	Female	14.86	22.30	478.98	80.54
Public school	Male	14.86	22.24	489.25	84.70

Figure 3.



Study Aim One

Regression results (presented in Table 3) were used to determine if there was a significant relationship with predicted MVPA during the week and sex, after adjusting for age and BMI. When sex was the only predictor in the model, there was no significant difference in the predicted MVPA of participants, $B = 8.42$, $SE = 4.74$, $t(1190) = 1.78$, $p = .08$. Sex

Table 3. Regression Results

Variable	**Beta**	**95% CI**	**p-value**
Sex			
Female			
Male	10	3.5, 17	0.003
Age			
13 years old			
14 years old	-35	-45, -24	<0.001
15 years old	-75	-85, -65	<0.001
16 years old	-117	-126, -107	<0.001
17 years old	-168	-179, -156	<0.001
BMI	-1.1	-1.9, -0.42	0.002

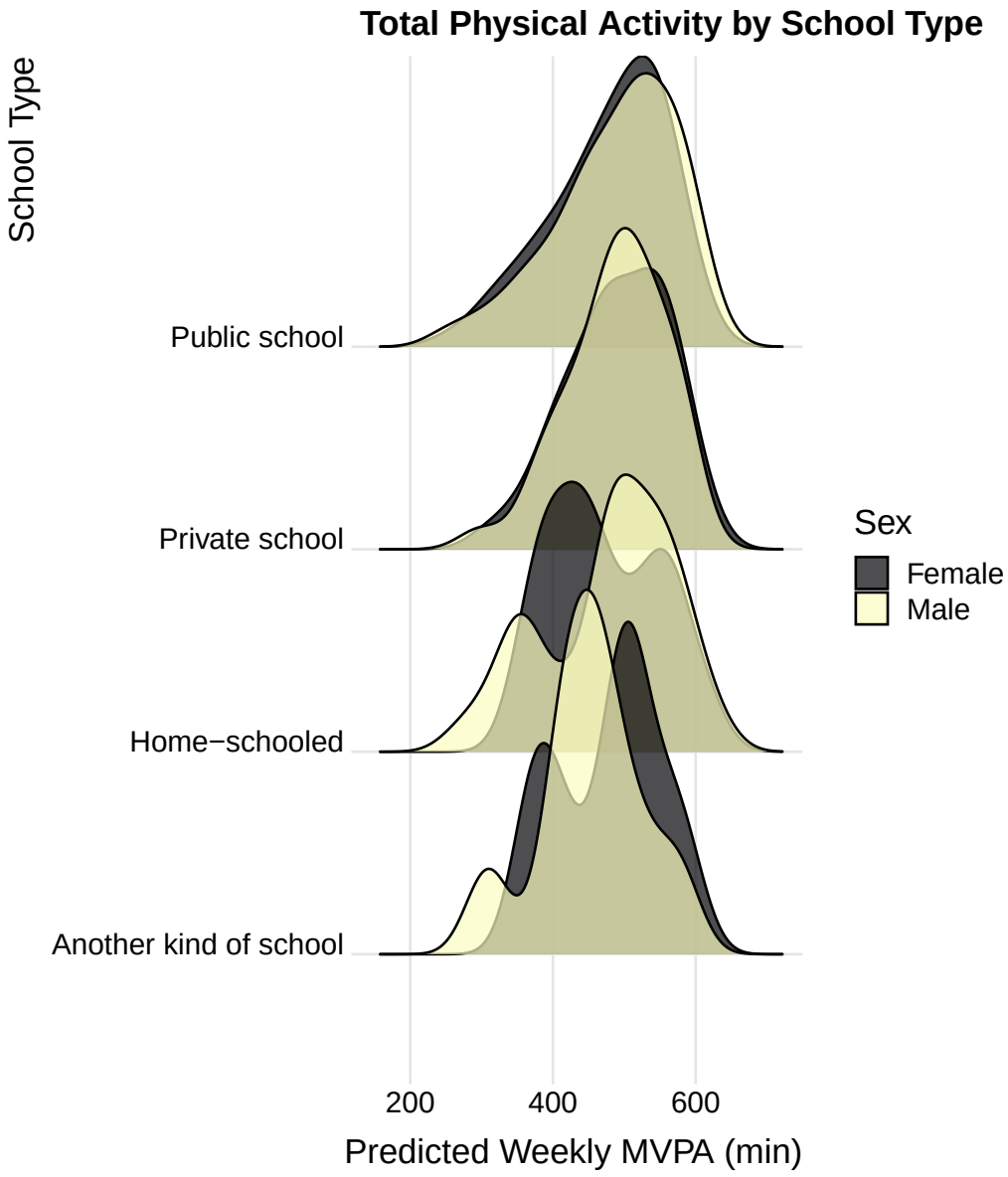
alone, explained only 0.26% of the variance in predicted MVPA, $F(1, 1190) = 3.16$, $p = .08$.

When age and bmi were adjusted for in the regression model, there was a significant difference in the relationship between sex and predicted MVPA during the week. Male adolescents engaged in 10.06 minutes more MVPA during the week than male participants, $SE = 3.35$, $t(1185) = -3.00$, $p < .001$.

Study Aim Two

An ANOVA was used to determine if there was a significant association between type of school attended and amount of physical activity performed during the week. The results indicate that there is no significant association, $F(3,1188) = 0.736$, $p = 0.531$, $p > .05$. Figure 4 provides a visualization of the associations between the variables of interest (School Type and Predicted Weekly MVPA) stratified by sex.

Figure 4.


Total Physical Activity by School Type
School Type
Public school
Private school
Home−schooled
Another kind of school
200
400
600
Predicted Weekly MVPA (min)
Sex
Female
Male

Discussion

This investigation sought to determine the pattern of adolescents' weekly MVPA based on various demographic characteristics, such as age and sex, and the type of school attended. It is important that patterns are identified so that any existing disparities are addressed as all adolescents can benefit from engaging in adequate MVPA. Based on this data analysis, females completed significantly less physical activity than males. Contributing factors to this association need to be explored in future research, as it can guide future physical activity program development. This research has implications for physical activity programs design, including in school physical education programs, and policy development and to promote physical activity in and outside of schools. Based on this analysis, the total amount of weekly physical activity is not associated with school type, suggesting that one type of school's physical education program does not surpass the others. It could be interpreted that all schools have effective programs, or that there is room for improvement for all. When taking into consideration the state of research about insufficient school physical education programs, it can be inferred that the latter is true and better programs and policies are needed. Effectively designed programs and policies can greatly impact a child's volume of weekly physical activity. Next steps for research include examining what motivates adolescents to complete physical activity, and how their social and physical environments moderate or mediate the amount of physical activity they complete.

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