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| Description of Physical Activity and Screen Time among U.S. Middle School Students |  | Supplementary materials: https://osf.io/z72qa/For correspondence: 2216086599@qq.com |

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*Please cite as: Xiaomei, Song et al. (2024). Description of Physical Activity and Screen Time among U.S. Middle School Students. SportRχiv*.

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# ABSTRACT

**Background:** Physical activity is important for students in secondary school, however, trends in PA among secondary school students have shown a significant decline globally. There is a need to understand the physical activity of middle school students. **Objective:** The first objective is to identify the PA levels and screen time of students in middle school. The second objective of the study intends to examine the PA levels and screen time among students of different genders. **Methods:** participants from four consecutive two-year cycles of National Health and Nutrition Examination Survey were included in this study. Spearman correlation model was used to identify the correlation between participants’ demographics, PA, and screen time data. Negative binomial regression model was used to describe students’ PA and screen time (Dependent variable) in different grades (Independent variables). Gender and Age were taken as control variables. **Results:** After the data preprocessing, 2516 participants were included in this study. Significant correlation has been found between grade and PA, instead of screen time. Negative binomial regression shows that students have lowest PA in their transition year Year 6, and their screen time decreased with the grade increased. Significant difference can be found across gender. Future efforts should focus on developing school transition support programs designed to improve PA.

**Keywords:** physical activity, school transition, screen time, adolescents

# INTRODUCTION

For students, physical activity (PA) in and out the classroom not only promotes overall health, but also enhances motivationand interest in learning and improves academic performance (Merriman et al., 2020). Some studies have been shown that PA can help students alleviate anxiety and depression and improveemotional stability and mental toughness (Zurita & Granda, 2023). Recently, trends in PA among secondary school students have shown a significant decline globally. Most adolescents are not meeting current PA guidelines (Hallal et al., 2012). In the United States, physical activity levels among middle school students declined between 2011 and 2017 (Ryu et al., 2020)). Considering that middle school years are a critical time for forming PA habits (Bryan & Solmon, 2012), there is a need to understand the physical activity of middle school students.

Numerous studies have indicated that students' PA decreases as their age (Haas et al., 2021). However, there is a paucity of research on differences in physical activity between grades in middle school. Considering that middle school is a critical period of transition from childhood to adolescence, during which students' behaviors may change significantly in a short period of time (Barney et al., 2017; Shikano & Noi, 2022), it is essential to examine PA differences between grades at this stage .

The purpose of this study was to explore the significant differences between students at different grade levels and to investigate the PA levels of students at different grade levels in the United States, providing a comprehensive understanding of the variations in these levels. The goal of this study is twofold. The first goal is to identify and compare the PA levels of students among students in grade 5 through 9, highlighting any grade-specific trends or patterns in PA. Given that some research suggests that screen time is an important factor in PA and that changes in PA may vary by gender, the second goal of the study is to examine the PA levels and screen time among students of different genders within the same grade range. The study will provide insights into gender-related differences in PA during these formative school years. The findings of the study will help enrich the existing body of knowledge about student PA and may inform the future development of educational and health policies that promote PA in school-aged children.

# METHOD

We employed a cross-sectional study design, utilizing data from the National Health and Nutrition Examination Survey (NHANES). NHANES gathers data on hundreds of variables to assess the prevalence of major diseases and risk factors, with the aim of promoting health and preventing disease (NHANES, 2022). NHANES surveys thousands of non-institutionalized civilians across the country to provide a nationally representative sample. The collected information is posted online in the form of data files and used in a variety of epidemiologic studies. The findings of study contribute to the formulation of public health policies and programs (NHANES, 2022).

Data from four consecutive two-year cycles were used in this study (NHANES 2011-2012, 2013-2014, 2015-2016, and 2017-2018). Prior to the 2011-2012 cycle, NHANES changed the PA measure. Data collection after the 2017-2018 cycle was incomplete due to the impact of the epidemic and the fact that the epidemic would have significantly impacted PA data, so it was not included in this study. Therefore, additional years could not be included in this study. Each participant provided written consent. The NCHS Ethics Review Board approved the measurement procedures and data collection, and authorized the online release of the data for public use.

The NHANES subjects in this study were U.S. students in grades 5 through 9. completely answered the three questions in the physical activity section were included in the analysis: PAQ715: "Number of hours of computer use in the past 30 days," PAQ710: "Number of hours of television or video viewing in the past 30 days," and PAQ706: "Number of days with at least 60 minutes of physical activity" or students who answered the PA-Youth section completely. They also needed complete data on gender, age, and grade level. A total of 2516 participants provided complete data for each variable and were included in the analysis.

## **Data analysis**

Descriptive data are presented as mean ± standard error (M±SE) for continuous variables and percentages ± SE for categorical variables. Gender, age, and grade level of the included sample were reported. In this study, PAQ706, PAQ710, and PAQ715 were the dependent variables, grade level was the categorical independent variable, and gender and age were the control variables. Since PAQ706, PAQ710, and PAQ715 were discrete data, they were analyzed using Poisson regression. If the model exhibited excessive dispersion, the data were analyzed using negative binomial regression to examine the effect of grade level on PA. To investigate the differences in PA by gender across grades. A gender\*grade interaction effect is also reported. All regression results were presented as regression coefficients, SE, test statistics, and p-values.

# Results

## **Description of demographics and PA results**

Table 1 demonstrates the demographic and PA results of the participants. There was a total of 2,516 participants in this study with an equal distribution of males and females (50% each). Participants were distributed across the five grade levels as follows: Year 5 (29.5%), Year 6 (19.1%), Year 7(19.2%), Year 8 (19.3%), and Year 9(13.0%).

The correlation among demographic variables (Gender, Age, Grade), physical activity (PAQ706), and screen time (PAQ710 and PAQ715) can be found in Table 2.

**Table1. Description of demographics and PA results**

| **Parameters** | **Levels** | **Stats** |
| --- | --- | --- |
| Gender | Male | 1257 (50.0%) |
|  | Female | 1259 (50.0%) |
| Grade | Year5 | 742 (29.5%) |
|  | Year6 | 480 (19.1%) |
|  | Year7 | 482 (19.2%) |
|  | Year8 | 485 (19.3%) |
|  | Year9 | 327 (13.0%) |
| Age | Mean ± SD | 12.8 ± 1.6 |
| PAQ706 | Mean ± SD | 4.2 ± 2.3 |
| PAQ710 | Mean ± SD | 2.5 ± 1.8 |
| PAQ715 | Mean ± SD | 2.8 ± 2.5 |

**Table 2. Correlation among demographics, PA, and screen time**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Gender** | **Age** | **Grade** | **PAQ706** | **PAQ710** | **PAQ715** |
| **Gender** |   |   |   |   |   |   |
| **Age** | -0.004 |   |   |   |   |   |
| **Grade** | -0.058\*\* | 0.028 |   |   |   |   |
| **PAQ706** | -0.116\*\*\* | 0.040\* | -0.175\*\*\* |   |   |   |
| **PAQ710** | 0.007 | 0.036 | 0.017 | -0.105\*\*\* |   |   |
| **PAQ715** | 0.008 | -0.001 | 0.109\*\*\* | -0.102\*\*\* | 0.235\*\*\* |   |

Computed correlation used spearman-method with listwise-deletion

## **PA and Screen time in each grade**

As shown in Table 3, there was a significant decline in the number of days that grade 6 were active for at least 60 minutes per week (b = -0.0728, z = -2.00, p = 0.045), with an OR of 0.930, indicating that students grade 6 were approximately 7% less likely to be active for at least 60 minutes per week than grade 5. PA increased as grade level increased, with a significant increase in the number of days in grade 9 (b = 0.1983, z = 2.62, p = 0.009), with an OR of 1.219, indicating that students grade 9 were approximately 22% more likely to be active for at least 60 minutes per week than grade 5.

As shown in Tables 4 and 5, there was a decrease in screen time in grade 6 and a significant decrease in grade 7 compared to grade 5 (PAQ710: b = -0.170, z = -2.623, p = 0.009; PAQ715: b = -0.162, z = -2.012, p = 0.044). Grade 8 spent more time watching TV than grade 6 and grade 7, while grade 9 spent less time in this area (b = -0.179, z = -1.805, p = 0.071). However, they spent more on computers in grade 9 (b = -0.125, z = -1.007, p = 0.314).

**Table 3. Negative Binomial Regression Results of** **Days physically active at least 60 min (PAQ706)**

| **Predictor** | **Coefficients** | **Std.Error** | **z.value** | **Odds.Ratio** | **P.value** |
| --- | --- | --- | --- | --- | --- |
| (Intercept) | 2.813 | 0.188 | 14.971 | 16.660 | 0.000\*\*\* |
| YEAR6 | -0.073 | 0.036 | -2.003 | 0.930 | 0.045\* |
| YEAR7 | 0.032 | 0.049 | 0.669 | 1.033 | 0.504 |
| YEAR8 | 0.099 | 0.061 | 1.616 | 1.104 | 0.106 |
| YEAR9 | 0.198 | 0.076 | 2.621 | 1.219 | 0.009\*\* |

Note: The significance codes are as follows: \*\*\* p < 0.001, \*\* p < 0.01, \* p < 0.05.

**Table 4. Results of Negative Binomial Regression on Hours watch TV or videos past 30 days (PAQ710)**

| **Predictor** | **Coefficients** | **Std..Error** | **z.value** | **Odds.Ratio** | **P.value** |
| --- | --- | --- | --- | --- | --- |
| (Intercept) | 0.230 | 0.248 | 0.930 | 1.259 | 0.352 |
| YEAR6 | -0.064 | 0.049 | -1.309 | 0.938 | 0.191 |
| YEAR7 | -0.170 | 0.065 | -2.623 | 0.844 | 0.009\*\* |
| YEAR8 | -0.096 | 0.080 | -1.200 | 0.908 | 0.230 |
| YEAR9 | -0.179 | 0.099 | -1.805 | 0.836 | 0.071 |

Note: The significance codes are as follows: \*\*\* p < 0.001, \*\* p < 0.01, \* p < 0.05.

**Table 5. Results of Negative Binomial Regression on Hours use computer past 30 days (PAQ715)**

| **Predictor** | **Coefficients** | **Std.Error** | **z.value** | **Odds.Ratio** | **P.value** |
| --- | --- | --- | --- | --- | --- |
| (Intercept) | -0.164 | 0.312 | -0.528 | 0.849 | 0.598 |
| YEAR6 | -0.121 | 0.062 | -1.951 | 0.886 | 0.051 |
| YEAR7 | -0.163 | 0.081 | -2.012 | 0.850 | 0.044\* |
| YEAR8 | -0.140 | 0.101 | -1.384 | 0.869 | 0.166 |
| YEAR9 | -0.125 | 0.124 | -1.007 | 0.882 | 0.314 |

Note: The significance codes are as follows: \*\*\* p < 0.001, \*\* p < 0.01, \* p < 0.05.

## **Gender Differences in PA and Screen Time Across Grades**

As shown in Table 6, boys' PA levels decreased slightly compared to grade 5(b = -0.079, z = -1.623, p = 0.104), but continued to increase from grade 7 to grade 9(seventh grade: b = 0.081, z = 1.416, p = 0.157; grade 8:: b = 0.202, z = 2.907, p = 0.004). In contrast, girls' PA levels generally declined with age, especially in grade 8 (b = -0.093, z = -1.453, p = 0.146) and grade 9 (b = -0.206, z = -3.180, p = 0.001), which was significant compared to grade 5.

As shown in Table 7 and Table 8, boys' screen time decreased slightly in grade 6 compared to grade 5 (PAQ710: b = -0.085, z = -1.283, p = 0.200; PAQ715: b = -0.184, z = -2.165, p = 0.677), but gradually increased from grade 7 (b = -0.201, z = -2.545, p = 0.011) tograde 9 (b = -0.151, z = -1.375, p = 0.169). In contrast, girls' screen time generally decreased with age, especially in grade 8 and grade 9.

**Table 6. Negative Binomial Regression Results on Gender Difference in Days physically active at least 60 min (PAQ706)**

| **Predictor** | **Coefficients** | **Std.Error** | **z.value** | **Odds.Ratio** | **P.value** |
| --- | --- | --- | --- | --- | --- |
| (Intercept) | 2.786 | 0.187 | 14.878 | 16.216 | 0.000\*\*\* |
| YEAR6 | -0.079 | 0.049 | -1.623 | 0.924 | 0.104 |
| YEAR7 | 0.081 | 0.057 | 1.416 | 1.084 | 0.157 |
| YEAR8 | 0.202 | 0.070 | 2.907 | 1.224 | 0.004\*\* |
| YEAR9 | 0.278 | 0.082 | 3.371 | 1.320 | 0.001\*\* |
| GENDER | -0.080 | 0.038 | -2.106 | 0.923 | 0.035\* |
| YEAR6:GENDER | 0.023 | 0.064 | 0.358 | 1.023 | 0.720 |
| YEAR7:GENDER | -0.093 | 0.064 | -1.453 | 0.911 | 0.146 |
| YEAR8:GENDER | -0.206 | 0.065 | -3.180 | 0.814 | 0.001\*\* |
| YEAR9:GENDER | -0.169 | 0.075 | -2.272 | 0.845 | 0.023\* |

Note: The significance codes are as follows: \*\*\* p < 0.001, \*\* p < 0.01, \* p < 0.05.

**Table 7. Negative Binomial Regression Results on Gender Difference in Hours watch TV or videos past 30 days (PAQ710)**

| **Predictor** | **Coefficients** | **Std.Error** | **z.value** | **Odds.Ratio** | **P.value** |
| --- | --- | --- | --- | --- | --- |
| (Intercept) | 0.235 | 0.248 | 0.948 | 1.265 | 0.343 |
| YEAR6 | -0.085 | 0.067 | -1.283 | 0.919 | 0.200 |
| YEAR7 | -0.201 | 0.079 | -2.545 | 0.818 | 0.011\* |
| YEAR8 | -0.211 | 0.094 | -2.246 | 0.810 | 0.025\* |
| YEAR9 | -0.151 | 0.110 | -1.375 | 0.860 | 0.169 |
| GENDER | 0.000 | 0.054 | 0.009 | 1.000 | 0.993 |
| YEAR6:GENDER | 0.035 | 0.086 | 0.403 | 1.036 | 0.687 |
| YEAR7:GENDER | 0.049 | 0.087 | 0.566 | 1.050 | 0.571 |
| YEAR8:GENDER | 0.201 | 0.085 | 2.378 | 1.223 | 0.017\* |
| YEAR9:GENDER | -0.094 | 0.097 | -0.962 | 0.910 | 0.336 |

Note: The significance codes are as follows: \*\*\* p < 0.001, \*\* p < 0.01, \* p < 0.05.

**Table 8. Negative Binomial Regression Results on Gender Difference in Hours watch TV or videos past 30 days (PAQ715)**

| **Predictor** | **Coefficients** | **Std..Error** | **z.value** | **Odds.Ratio** | **P.value** |
| --- | --- | --- | --- | --- | --- |
| (Intercept) | -0.130 | 0.312 | -0.417 | 0.878 | 0.677 |
| YEAR6 | -0.184 | 0.085 | -2.165 | 0.832 | 0.030\* |
| YEAR7 | -0.250 | 0.099 | -2.527 | 0.779 | 0.012\* |
| YEAR8 | -0.246 | 0.118 | -2.087 | 0.782 | 0.037\* |
| YEAR9 | -0.213 | 0.138 | -1.542 | 0.808 | 0.123 |
| GENDER | -0.011 | 0.069 | -0.157 | 0.989 | 0.875 |
| YEAR6:GENDER | 0.111 | 0.110 | 1.012 | 1.117 | 0.312 |
| YEAR7:GENDER | 0.156 | 0.109 | 1.437 | 1.169 | 0.151 |
| YEAR8:GENDER | 0.184 | 0.107 | 1.720 | 1.202 | 0.085 |
| YEAR9:GENDER | 0.153 | 0.120 | 1.275 | 1.165 | 0.202 |

Note: The significance codes are as follows: \*\*\* p < 0.001, \*\* p < 0.01, \* p < 0.05.

# Discussion

The first goal of this study is to identify and compare the PA and screen time among grade 5-9. The results indicate that PA is at its lowest in grade 6, the middle school transition year. We believe this may be due to the effects of school transition. School transitions can be defined as the process of moving from one educational institution to another and is considered important and challenging for students (Hopwood et al., 2016; Zeedyk et al., 2003). In the United States, this transition usually occurs between grade 5 and grade 6, at approximately 11 to 12 years of age. During this period, students must adjust to a new school environment, different academic expectations, and new social dynamics, making it one of the most stressful events in a young person's life. This transition can negatively affect their PA and screen time (Chong et al., 2022; Marks et al., 2015). Our findings are consistent with these observations. However, in grade 7, 8, and 9, students' PA levels increase compared to grade 5, which contradicts previous research showing that PA decreases with age (Chong et al., 2022; Marks et al., 2015). This difference may be due to increased academic stress as students enters middle school. Previous research indicated that academic pressure and the subsequent reduction in leisure time negatively impact children's PA levels, leading to an increase in sedentary lifestyles and screen time, which is associated with poorer physical health outcomes (Colley et al., 2011a; Troiano et al., 2008). Another study also showed that high academic stress and heavy homework loads were associated with lower levels of PA among middle school students too (Holland et al., 2021). This substitution of study time for PA time has led to an increase in sedentary behavior, which negatively affects physical and mental health (Ishii et al., 2020; Zurc & Planinšec, 2022). Therefore, policymakers should be urged to reduce students' academic pressure to help improve their PA levels. Since this decline in PA occurs only in the first year of transition, future efforts should focus on developing school transition support programs designed to improve PA. These programs will help students through the most challenging part of the transition and prepare them for the rest of middle and high school. However, the majority of current school transition support programs focus on students' social and emotional health, with little focus on PA. Future research should develop more PA-supportive school transition programs.

Research also indicates that the reduction in physical activity PA may be related to an increase in screen time. The widespread use of electronic devices has led to more sedentary activities (Colley et al., 2011b). Activities such as watching TV, using computers, and playing mobile games are gradually replacing traditional outdoor games and sports (Ne’matullah et al., 2022). A study on PA and screen time has documented this shift, highlighting a clear correlation between increased screen use and decreased PA (Ma et al., 2020). Interestingly, our study found no increase in screen time, including television viewing and computer use; in fact, screen time decreased significantly, reaching a nadir in grade 7 before rising again in grade 8. This inconsistency suggests that the changes in screen time do not reflect changes in PA. Given that students are neither increasing their PA nor their screen time, it raises the question of where their time is being spent. We argue that changes in screen time are influenced not only by academic stress but also by changes in social relationships. Transitioning to a new and unfamiliar environment requires students to invest time in building new friendships. Previous research has shown that peer influences and social activities have a significant impact on adolescents' screen time, with students preferring non-screen social activities (Schmidt et al., 2020). Consequently, screen entertainment time decreases. By grade 8, students are fully acclimated to their new environments and social circles, allowing for more time for screen activities. However, by grade 9, the increased academic pressure on students about to transition from middle school to high school leads to another decrease in screen recreation time. Studies have shown that ninth graders face significant stress due to the middle school transition, leading to increased anxiety, depression and peak academic stress (Chen et al., 2023). Hence, screen entertainment time declines again in grade 9. Based on our findings, the decline in students' PA cannot be attributed simply to increased sedentary and screen time. In addition, students' PA and screen time are likely to be influenced by the school environment (academic and social aspect), which further justifies the need for PA intervention programs in schools. However, due to the limitations of the experimental design, we were unable to consider the potential impact of the interaction between school and adolescence on students' PA. Future research needs to examine PA across grades and ages.

 Supriyanto et al. (2021) found that male students were more inclined to participate in sports and competitions during their leisure time, whereas female students tend to participate in low-intensity or social activities, resulting a gender disparity in PA. This study reached similar conclusions, indicating that male students' PA showed a gradual increase with age, while female students' PA decreased with age. We believe that another possible reason for this result is that female students usually face more time management challenges, possibly due to greater responsibilities in family and social roles, reducing the time they can allocate to physical activity (Moscatelli et al., 2023). Additionally, female students often tend to be more concerned with body image, and their concern for appearance and self-esteem can affect their participation in physical activities and their concern for appearance and self-esteem can affect their participation in physical activities. In contrast, male students are more concerned with physical fitness and competitiveness (Rašidagić et al., 2020).

It is generally accepted that males typically use video games more frequently as a means of social interaction (Zapata-Lamana et al., 2021), and growing up they tended to choose video games and physical activity as their primary forms of entertainment (Cui et al., 2023). This resulted in boys having more screen time than girls. However, the results of this study differ from previous findings. Compared to grade 5, boys' screen time decreased sharply in grade 6, reaches its lowest point in grade 7, and then slightly increases from grade 8 to grade 9. Conversely, screen time for girls continued to rise as they entered middle school and did not decrease until grade 9.

In addition to the effects of sociocultural expectations mentioned earlier, these results may indicate that screen time becomes more significant for female students during middle school. Studies have found that female students are more inclined to use social media to communicate and build social relationships (Boers et al., 2019), and social media is a crucialmean for them to fit into groups (Schoeppe et al., 2016). The increase in screen time for girls during middle school may be related to their desire to enhance social interactions and integrate into peer groups.

Another interesting aspect in the results is that decreased physical activity (PA) and screen time for boys may indicate that PA and screen time are not strongly correlated for middle school boys, who tend to spend time on other activities. However, a significant correlation between PA and screen time was found for girls. A decrease in PA led to an increase in screen time. This suggests that if the goal is to reduce girls' screen time, increasing their PA levels is the best option. In summary, bearing in mind the poor performance of female students in both PA and screen time, more targeted interventions need to be designed to help girls increase their PA and reduce their screen time.

Some limitations are associated with our findings. To begin with, this study was a cross-sectional study that identified only PA and screen time for students of different ages. While we compared their results to some extent, this does not determine the true trend of students' PA as they age. This needs to be further verified through longitudinal studies in the future. Second the sample size of this study is relatively limited. Despite the relatively balanced gender ratio and age, the total sample size is only 2000. A larger sample size is needed for future studies to confirm our findings. To conclude, the screen time and PA measures used in this study were obtained through questionnaires, not PA accelerometers. Such self-reported data may be subject to recall bias and may not accurately represent students' PA and screen time.

# Conclusion

A significant difference in PA and screen time was found in this study for students in grades 5 through 9, particularly during the transition to secondary school and the final year of secondary school. A need for targeted interventions, particularly PA support for girls, is emphasized by the results, and it is recommended that school transition programs should include components that focus on physical health. A longitudinal design and larger sample size should be used in future studies to further explore these trends and develop effective strategies to promote healthy behaviors among students.

# Contributions

All authors contributed equally to this work.

Contributed to conception and design: Kevin Chow, Xiaomei Song, Zikun Zhao

Contributed to analysis and interpretation of data: Yanxuan Jin, Siyo Chan

Drafted and/or revised the article: Xiaomei Song, Zikun Zhao, Yanxuan Jin

Approved the submitted version for publication: Zikun Zhao, Siyo Chan

# Funding information

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

# Data and Supplementary Material Accessibility

The data used in this manuscript are publicly available from the National Health and Nutrition Examination Survey (NHANES) database. The specific data files utilized were from the 2015-2018 survey cycles. NHANES data can be accessed through the CDC's website at <https://www.cdc.gov/nchs/nhanes/index.htm>. The R language code for analyzing the data can be found in https://osf.io/z72qa/.

# REFERENCES

Barney, D. C., Pleban, F., & Lewis, T. (2017). Relationship between physical activity and stress among junior high school students in the physical education environment.

Boers, E., Afzali, M. H., Newton, N., & Conrod, P. (2019). Association of Screen Time and Depression in Adolescence. *JAMA Pediatrics*, *173*(9), 853-859. <https://doi.org/10.1001/jamapediatrics.2019.1759>

Bryan, C. L., & Solmon, M. A. (2012). Student motivation in physical education and engagement in physical activity. *Journal of sport behavior*, *35*(3), 267.

Chen, H., Guo, H., Chen, H., Cao, X., Liu, J., Chen, X., Tian, Y., Tang, H., Wang, X., & Zhou, J. (2023). Influence of academic stress and school bullying on self-harm behaviors among Chinese middle school students: The mediation effect of depression and anxiety. *Frontiers in public health*, *10*.

Chong, K. H., Dumuid, D., Cliff, D. P., Parrish, A.-M., & Okely, A. D. (2022). Changes in 24-Hour Domain-Specific Movement Behaviors and Their Associations With Children’s Psychosocial Health During the Transition From Primary to Secondary School: A Compositional Data Analysis. *Journal of Physical Activity and Health*, *19*(5), 358-366. <https://doi.org/10.1123/jpah.2021-0630>

Colley, R. C., Garriguet, D., Janssen, I., Craig, C. L., Clarke, J., & Tremblay, M. S. (2011a). Physical activity of Canadian adults: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health reports*, *22*(1).

Colley, R. C., Garriguet, D., Janssen, I., Craig, C. L., Clarke, J., & Tremblay, M. S. (2011b). Physical activity of Canadian children and youth: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health reports*, *22*(1), 15.

Cui, Z., Zou, P., Lin, Z., Cao, Y., & Luo, Y. (2023). Gender Differences in Excessive Screen Time among Chinese High School Students in Henan Province. *International Journal of Environmental Research and Public Health*, *20*(1), 721. <https://www.mdpi.com/1660-4601/20/1/721>

Haas, P., Yang, C.-H., & Dunton, G. F. (2021). Associations Between Physical Activity Enjoyment and Age-Related Decline in Physical Activity in Children—Results From a Longitudinal Within-Person Study. *Journal of Sport & Exercise Psychology*, *43*(3), 205-214. <https://doi.org/10.1123/jsep.2020-0156>

Hallal, P. C., Andersen, L. B., Bull, F. C., Guthold, R., Haskell, W., & Ekelund, U. (2012). Global physical activity levels: surveillance progress, pitfalls, and prospects. *The lancet*, *380*(9838), 247-257.

Holland, M., Courtney, M., Vergara, J., McIntyre, D., Nix, S., Marion, A., & Shergill, G. (2021). Homework and Children in Grades 3–6: Purpose, Policy and Non-Academic Impact. *Child & Youth Care Forum*, *50*(4), 631-651. <https://doi.org/10.1007/s10566-021-09602-8>

Hopwood, B., Hay, I., & Dyment, J. (2016). The transition from primary to secondary school: Teachers’ perspectives. *The Australian Educational Researcher*, *43*(3), 289-307. <https://doi.org/10.1007/s13384-016-0200-0>

Ishii, K., Aoyagi, K., Shibata, A., Javad Koohsari, M., Carver, A., & Oka, K. (2020). Joint Associations of Leisure Screen Time and Physical Activity with Academic Performance in a Sample of Japanese Children. *International Journal of Environmental Research and Public Health*, *17*(3), 757. <https://www.mdpi.com/1660-4601/17/3/757>

Ma, C., Zhou, L., Xu, W., Ma, S., & Wang, Y. (2020). Associations of physical activity and screen time with suboptimal health status and sleep quality among Chinese college freshmen: A cross-sectional study. *PLoS One*, *15*(9), e0239429. <https://doi.org/10.1371/journal.pone.0239429>

Marks, J., Barnett, L. M., Strugnell, C., & Allender, S. (2015). Changing from primary to secondary school highlights opportunities for school environment interventions aiming to increase physical activity and reduce sedentary behaviour: a longitudinal cohort study. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 59. <https://doi.org/10.1186/s12966-015-0218-0>

Merriman, W., González-Toro, C. M., & Cherubini, J. (2020). Physical Activity in the Classroom. *Kappa Delta Pi Record*, *56*(4), 164-169. <https://doi.org/10.1080/00228958.2020.1813518>

Moscatelli, F., La Torre, M. E., Vasco, P., Valenzano, A., Monda, V., Cibelli, G., Messina, G., & Polito, R. (2023). The Differences in Physical Activity Levels of Male and Female University Students. *Physical Education Theory and Methodology*, *23*(3), 431-437.

Ne’matullah, K. F., Abd Talib, N., Mee, R. W. M., Seong, L., Pek, S. A., & Ismail, M. R. (2022). The impact of outdoor play on children’s well-being: A scoping review Dampak bermain di luar ruangan pada kesejahteraan anak: Tinjauan pelingkupan. *Masyarakat, Kebudayaan Dan Politik*, *35*(3), 282-296.

NHANES. (2022). [https://doi.org/https://www.cdc.gov/nchs/nhanes/about\_nhanes.htm](https://doi.org/https%3A//www.cdc.gov/nchs/nhanes/about_nhanes.htm).

Rašidagić, F., Nurković, N., Dž, I. T., Hadžibulić-Nurković, H., Nikšić, E., & Kapo, A. (2020). Differences between morphological characteristics and motoric capabilities of physically active and inactive female students. *Pedagogy of physical culture and sports*, *24*(1), 30-35.

Ryu, S., Loprinzi, P., Kim, H., & Kang, M. (2020). Temporal Trends in the Association between Participation in Physical Education and Physical Activity among U.S. High School Students, 2011–2017. *International Journal of Environmental Research and Public Health*, *17*(7), 2357. <https://www.mdpi.com/1660-4601/17/7/2357>

Schmidt, S. C. E., Anedda, B., Burchartz, A., Eichsteller, A., Kolb, S., Nigg, C., Niessner, C., Oriwol, D., Worth, A., & Woll, A. (2020). Physical activity and screen time of children and adolescents before and during the COVID-19 lockdown in Germany: a natural experiment. *Scientific Reports*, *10*(1), 21780. <https://doi.org/10.1038/s41598-020-78438-4>

Schoeppe, S., Vandelanotte, C., Bere, E., Lien, N., Verloigne, M., Kovács, É., Manios, Y., Bjelland, M., Vik, F. N., & Van Lippevelde, W. (2016). The influence of parental modelling on children’s physical activity and screen time: Does it differ by gender? *European Journal of Public Health*, *27*(1), 152-157. <https://doi.org/10.1093/eurpub/ckw182>

Shikano, A., & Noi, S. (2022). Go/no-go task performance of Japanese children: Differences by sex, grade, and lifestyle habits. *Frontiers in public health*, *10*, 883532.

Supriyanto, A., Kriswanto, E. S., Prasetyo, Y., & Andrianto, S. D. (2021). The difference between male and female student's physical activity in urban region during school recess. *Jurnal Keolahragaan*, *9*(2), 202-209.

Troiano, R. P., Berrigan, D., Dodd, K. W., Masse, L. C., Tilert, T., & McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Medicine and science in sports and exercise*, *40*(1), 181.

Zapata-Lamana, R., Ibarra-Mora, J., Henriquez-Beltrán, M., Sepúlveda-Martin, S., Martínez-González, L., & Cigarroa, I. (2021). Aumento de horas de pantalla se asocia con un bajo rendimiento escolar. *Andes pediatrica*, *92*(4), 565-575.

Zeedyk, M. S., Gallacher, J., Henderson, M., Hope, G., Husband, B., & Lindsay, K. (2003). Negotiating the Transition from Primary to Secondary School: Perceptions of Pupils, Parents and Teachers. *School Psychology International*, *24*(1), 67-79. <https://doi.org/10.1177/0143034303024001010>

Zurc, J., & Planinšec, J. (2022). Associations between Physical Activity and Academic Competence: A Cross-Sectional Study among Slovenian Primary School Students. *International Journal of Environmental Research and Public Health*, *19*(2), 623. <https://www.mdpi.com/1660-4601/19/2/623>

Zurita, W. P. B., & Granda, E. A. C. (2023). PHYSICAL ACTIVITY AND COGNITIVE DEVELOPMENT IN HIGH SCHOOL STUDENTS. *Revista Científica Educ@ ção*, *8*(13).