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STRUCTURED VERSUS UNSTRUCTURED DAYS: PHYSICAL ACTIVITY AMONG ADOLESCENTS DURING COVID-19

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Background: Structured settings, specifically school, have been understood to promote physical activity (PA) in children. During the COVID-19 pandemic, students were required to attend school remotely, in an unstructured setting. The purpose of this study is to examine the physical activity of children during the weekdays, weekends, and break during COVID-19.

Methods: Participants were asked to fill out a baseline survey prior to the intervention. For one week, students wore Actigraph GT3X+s for baseline measure mures. Afterwards, they were asked to wear a FitBit Inspire 2 for six weeks. Data was collected from the Fitbits using Fitabase (Small Steps Labs LLC., San Diego, CA). Descriptive Statistics and means and standard deviations of MVPA and steps were summarized.

Results: Students accumulated 765.7 more steps per day ($p < 0.0001$) during regular school days compared to winter break. Students accumulated 779.5 more steps per day ($p < 0.0001$) and 12.3 more MVPA minutes per day ($p = 0.0004$) during weekdays compared to weekend days. Gender differences were also significant in that boys are more active than girls for both steps ($\beta = 1439.3$, $p < 0.0001$) and MVPA ($\beta = 34.1$, $p < 0.0001$).

Conclusion: Students had lower levels of MVPA and steps during the weekends and the winter break.

INTRODUCTION

Insufficient levels of physical activity have been shown to drastically affect a child's development for some time. Studies have shown that inactive children are likely to become inactive adults which put them at risk for heart disease, cancer, and other diseases. Cardiorespiratory fitness, bone and muscle strength, and weight control are known to improve with regular physical activity.

As the surveillance evidence for physical activity in children and adolescents accumulates, there is an increasing understanding of how sedentary children have become in the last decade. Physical activity has decreased significantly for boys between 2001 to 2016 in particular. In 2016, 80% of students aged 11-17 were insufficiently active (Guthold, 2020). In another study done in the United States in 2018, only about 24% of children aged 6-7 participated in 60 min of physical activity every day, 26% of youth in high school participated in 60 min of physical activity, and 47% participated in the 60 min for five days a week. In that same study, it was found that approximately 33% of children and adolescents aged 6-19 met the 2 hour screen time limit (WHO, 2002). Interest in the health consequences of excessive sedentary behavior has increased with both children and adults becoming more sedentary in their day-to-day roles. Sedentary lifestyles increase mortality rates, double the risk of cardiovascular diseases, diabetes, and obesity . Physical inactivity can lead to an energy imbalance which can increase the risk of being overweight or obese, increase risk factors for heart disease such as high blood pressure, obesity, insulin resistance, and glucose intolerance, increase the risk of type 2 diabetes, and lead to low bone density which can lead to osteoporosis (CDC). Regular physical activity and exercise are important to maintain and improve the health of children and adolescents during development. The physical activity of children, in particular, can be highly dependent on the structure of their day. This is heavily tied in with their schedule as well as how

their own schools can impact and improve their physical activity levels. For example, approximately 33% of school districts promote walking or biking to and from school. Only 30% of adolescents in high school attended physical education courses 5 days a week and 52% attended once a week (Katzmarzyk, 2018). Children and adolescents spend the majority of their time during the academic school year at school so when schools do not implement physical activity, children become mostly sedentary in classroom settings.

School days provide children and adolescents with structure in their day-to-day lives. Children become accustomed to the routine of waking up, going to school, and coming home. On non-school days, the routine can become disrupted. Breaks, including weekends, can give children the excuse to decrease their physical activity levels and be sedentary for long periods. On top of this, a typical school day provides children with supervision and instruction. Usually, breakfast and lunch are eaten at a consistent time and meals tend to be better balanced nutritionally. Because of this, many studies have been done on how weekends impact the health and development of children. In a study done recently from the International Children's Accelerometer Database from June 2019, boys and girls accumulated 12.6 min/day and 9.4 min/day more moderate-to-vigorous physical activity on weekdays versus weekend days respectively (Brazendale, 2021). In another study of the same author, structured environments of weekdays were suggested to protect children by regulating their obesogenic behaviors through physical activity opportunities (Brazendale, 2017). It is important to observe the changes that occur in the routine of adolescents during the weekend to maintain healthy habits from the weekdays.

Many studies have shown that children and adolescents become less active, more sedentary, and consume more sugar during weekend days. These detriments can be prolonged during long breaks such as the winter and summer breaks which can span from weeks to months.

In a study done on students who attended summer school versus students who did not, significant increases in body weight and % body fat were found in summer school non-attendants during the summer. The summer school program was shown to prevent weight gain and promote overall healthier well-being through the structured environment, restricted food access, and scheduled time for exercise (Park, 2015). In another study, children who attended a summer camp had a greater activity index than children who spent more time with their parents over the summer. The children who did not attend the summer camp were four times more likely to eat their meals in front of a television screen (Tovar, 2010). An article from 2010 found slightly different results. In this article, children accumulated higher vigorous physical activity out of school compared to during school. However, overall, the participants were less sedentary during the week compared to the weekend (Steele, 2010).

Studies also documented the decline of PA during COVID-19 due to “closure of school and parks and the cancellation of youth sports and activity classes around the United States" (Genevieve, 2020) Prior to the pandemic, children met their physical activity needs through school and these extracurricular activities. After the pandemic began, the only means of meeting their physical activity were through free play, such as tag, and going on walks. This occurred mostly during the early-COVID-19 periods. On top of this, most classes, which children already displayed sedentary behaviors in, became remote/streamed services which required students to use monitors for long periods of time. A reason that this is significant is because children who participated in more physical activity and less screen time had better mental health outcomes (Tandon, 2021). However, there is little evidence about children PA between structured vs. unstructured days during COVID-19. Thus, the purpose of the current study is to examine the physical activity levels between school days vs winter break. The secondary purpose is to compare the physical activity levels between weekdays versus weekend days.

METHODS

Participants were a non-probability convenience sample of 70 middle school students (36 girls and 34 boys) from Hillside Middle School located in Salt Lake City, Utah. Participating students were from seventh and eighth grade. Written consent forms were given to be distributed by the school's physical education teacher obtained from students and the parents of the students prior to the start of the study.

Prior to the intervention, baseline surveys, and activity monitoring devices were given to the students. Students were asked to come during their physical education class period to take the survey in a computer lab. Afterward, all 70 students were given activity monitoring devices to wear for one week for baseline data. The baseline activity was measured using Actigraph GT3X+ and GT3X-BT. Students were told to wear these around their hips and followed the same protocol as wearing the Fitbits, only taking them off at night and when participating in water activities. The GT3X+ and GT3X-BT have been shown to be valid measurements for physical activity in children.

The baseline surveys given prior to the intervention had three components: demographic, diet, and physical activity. Physical activity was measured for six weeks (from December 6th, 2021 to January 16th, 2022) using Fitbit Inspire 2. Participants were asked to wear a Fitbit every day of the week during their school days and winter break. Each student wore the Fitbit before school until the end of the day, only taking it off when participating in water-related activities. The Fitbits were worn on the non-dominating hand of the participants to avoid the measurement of excessive activity from the movement of their dominant hand. The Fitbits were used to record steps each day of the week. Students were asked to download the Fitbit app to view and log in additional data. Minute-by-minute data of steps and active minutes was downloaded through Fitabase (Small Steps Labs LLC., San Diego, CA). The same minimum ten hours of wearing

time was applied to determine a valid day for Fitbit. Only data from valid days were included in the analysis. Step and MVPA minutes data were aggregated daily first.

Statistical Analyses

The descriptive statistics consisted of the reporting of counts and frequencies for categorical data of sex, grade level, parent education, race, health status, and weight change. Means and standard deviations for continuous data of steps and MVPA were also summarized. Gender differences of demographic variables were tested with Chi-square test and baseline steps and MVPA were examined using independent t-tests. The difference between weekday and weekend on the main outcome measures of daily steps and MVPA were tested using ANOVA. The same process was repeated for school days vs winter days comparison. Fitbit data for valid wear days, weekly average steps, and weekly average MVPA were plotted by group over the 6-week intervention.

Linear regressions were ran using daily steps and MVPA as the dependent variable, separately. The linear model examined the time difference (weekday vs weekend; school days vs winter break) by controlling for grade level, gender, race, intention of weight change, resting heart rate, Fitbit wear time, and health status. All analyses were conducted with SAS 9.4 and the alpha level was set at 0.05.

RESULTS

A total of 56 out of 70 participants provided valid data. The sample characteristics for the total sample and within each gender group are reported in Table 1. Most of the participating students were Caucasian (70%), wanting to stay the same weight (70%), and had parents with some form of college degree (80%). Statistical differences were found in boys and girls with boys having higher average MVPA and average steps than girls.

Table 1. Baseline survey results

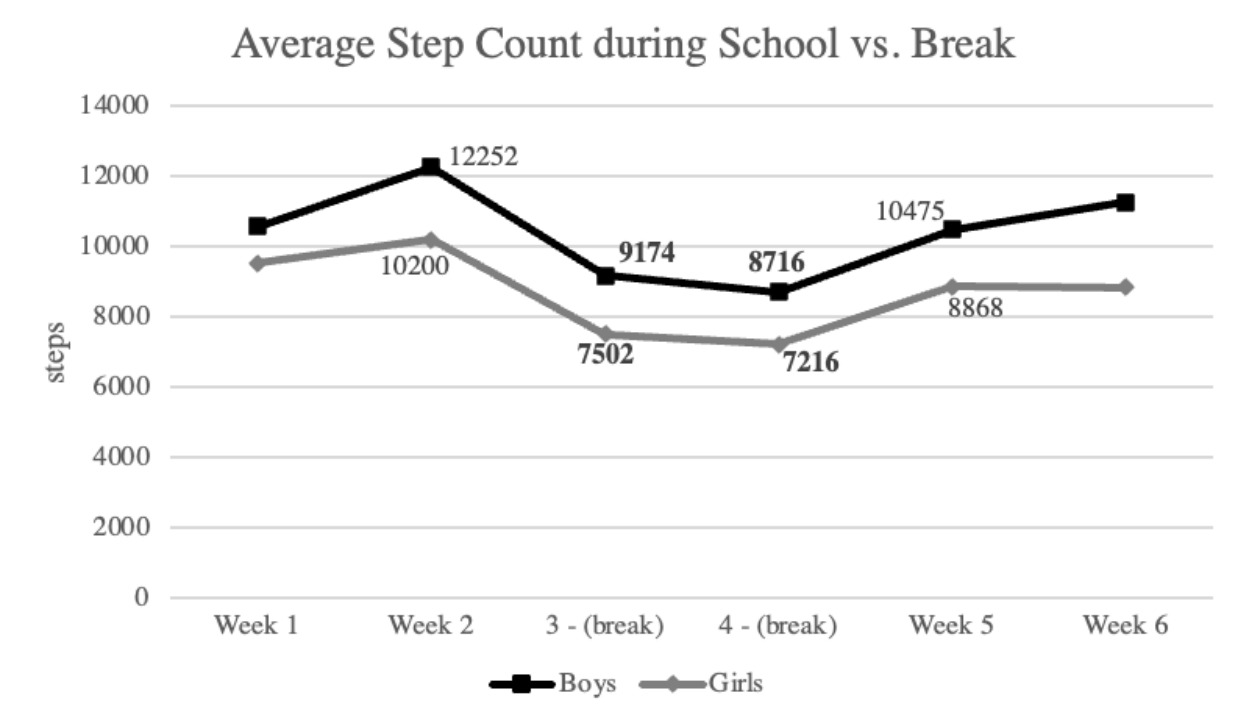
	All		Boys (N=27)		Girls (N=29)	
	N	%	N	%	N	%
Grade						
7th grade	24	42.9	15	55.6	9	31.0
8th grade	32	57.1	12	44.4	20	69.0
Parent Education						
Less than High school	5	9.1	2	7.4	3	10.7
High school	0	0.0	0	0.0	0	0.0
Some college	5	9.1	2	7.4	3	10.7
College or higher	45	81.8	23	85.2	22	78.6
Race						
American Indian	2	3.6	1	3.7	1	3.4
Asian	2	3.6	1	3.7	1	3.4
African American	2	3.6	0	0.0	2	6.9
Native Hawaiian	3	5.4	2	7.4	1	3.4
White	42	75.0	20	74.1	22	75.9
Hispanic	4	7.1	2	7.4	2	6.9
Non-Hispanic White	1	1.8	1	3.7	0	
Weight Change						
Lose weight	15	27.3	7	26.9	8	27.6
Gain weight	3	5.5	2	7.7	1	3.5
Stay the same	37	67.3	17	65.4	20	69.0
Health Status						
Excellent	20	35.7	12	44.4	8	27.6
Very good	15	26.8	8	29.6	7	24.1
Good	17	30.4	5	18.5	12	41.4
Fair	4	7.1	2	7.4	2	6.9

Data was collected from students daily by the monitors for six weeks. Boys generally were more active than girls, with an average step count of 10,404 steps and MVPA of 58.4

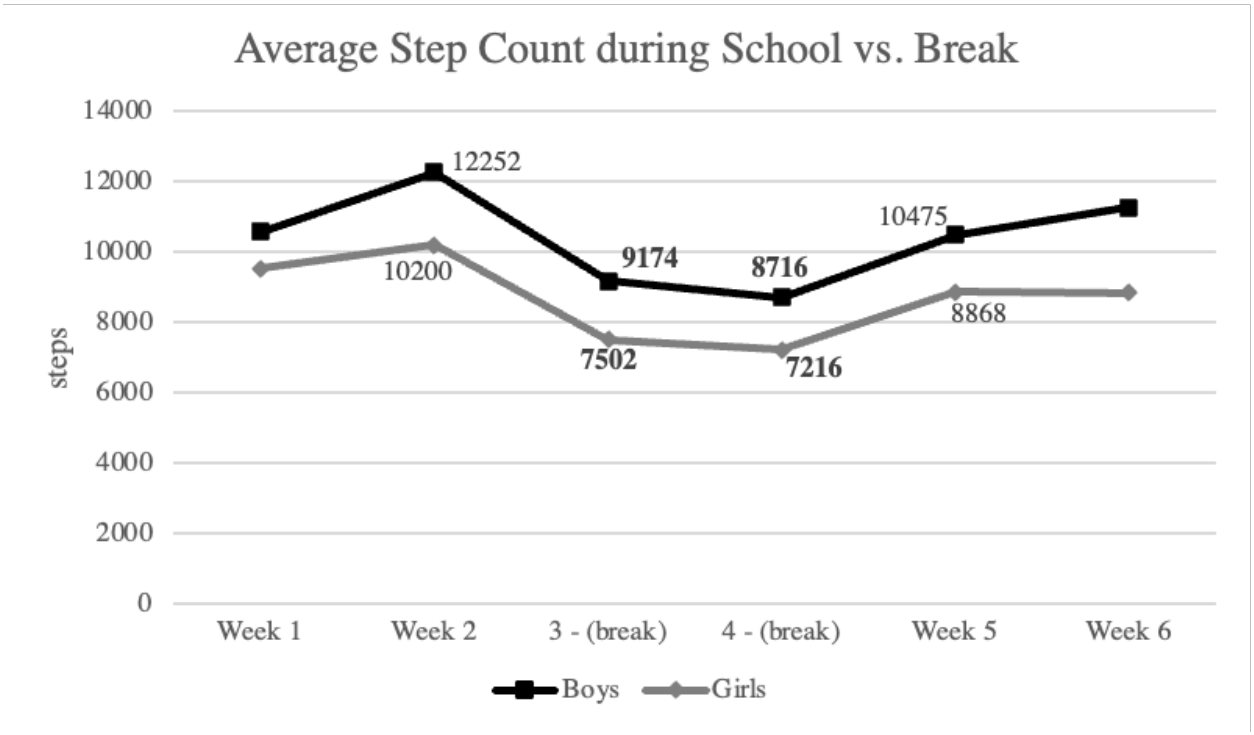
minutes. Girls had an average step count of 8,694 steps and an MVPA of only 19.6 minutes compared to boys. Overall, students accumulated an average step count of 10,422 steps during the school weeks and 6,416 steps on the weekends (Figure 1a). This is an average decrease of 4,006 steps during the 2-week winter break. Similarly, MVPA also decreased during the break (Figure 1b). The average MVPA during the school weeks and winter break was 41.5 minutes and 34.0 minutes, respectively. Both girls and boys were overall less active during the winter break weeks than during the school weeks. In both these figures, girls had a lower average step count and MVPA compared to boys.

Figure 1a and 1b – Week-by-week averages of physical activity levels

a.)



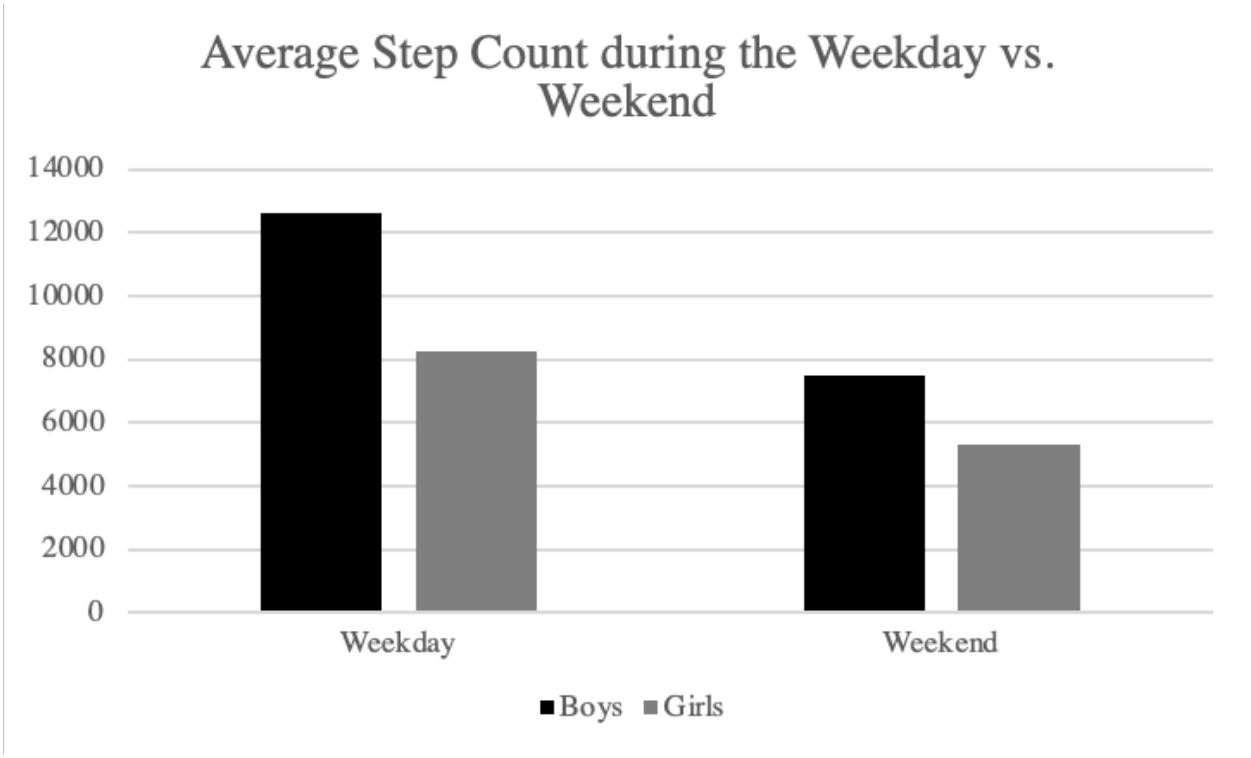
b.)



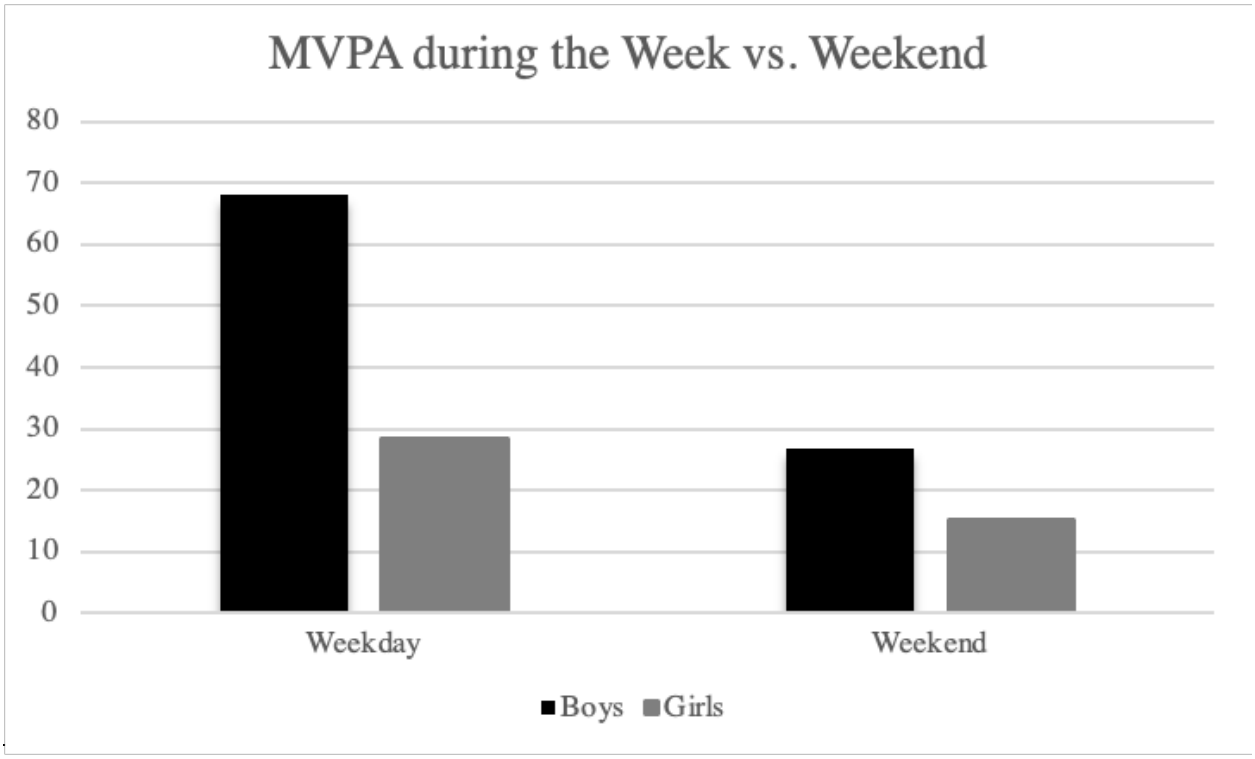
During the weekdays, students had an overall average step count of 10,248 compared to the 8,152 steps on the weekends (Figure 2a). Boys had an average step count of 12,607 steps on the weekdays and 7,502 steps on the weekends. Compared to that, girls had an average step count of 8,237 steps on the weekdays and 5,329 on the weekends. Students had an overall reduction of 2,096 steps on the weekends. The average MVPA during the weekdays and weekends was 41.5 minutes and 34.0 minutes, respectively (Figure 2b). In both these figures, girls and boys had a lower average step count and MVPA on the weekends compared to the weekdays. There were similar differences between boys and girls in MVPA during the weekdays versus the weekends. Boys had an average MVPA of 68.1 minutes during the weekdays and 26.9 during the weekends. Girls had an average MVPA of 26.9 minutes and 15.3 minutes on the weekdays and the weekends, respectively.

Figures 2a and 2b – Weekdays vs. weekend averages of physical activity levels

a.)


Average Step Count during the Weekday vs. Weekend
14000
12000
10000
8000
6000
4000
2000
0
Weekday
Weekend
Boys
Girls

b.)


MVPA during the Week vs. Weekend
80
70
60
50
40
30
20
10
0
Weekday
Weekend
Boys
Girls

The regression results showed that there is a significant difference in steps/day and MVPA/day between winter break and school days as well as weekday and weekend comparison (table 2 and 3). Students accumulated 765.7 more steps per day ($p < 0.0001$) during regular school days compared to winter break. Students accumulated 779.5 more steps per day ($p < 0.0001$) and 12.3 more MVPA minutes per day ($p = 0.0004$) during weekdays compared to weekend days. Gender differences were also significant in that boys are more active than girls for both steps ($\beta = 1439.3$, $p < 0.0001$) and MVPA ($\beta = 34.1$, $p < 0.0001$). Lower resting heart rate is significantly associated with higher daily steps ($p = 0.03$).

Table 2. Regression model testing winter and weekend differences in steps as the outcome.

	Estimate	Std. Error	t-value	p-value
Winter	6.3	3.5	1.8	0.0725
Weekend	12.3	3.5	3.57	0.0004
Winter & weekend	-8.2	4.1	-2.01	0.0446
Weight Change				
Lose weight	14.6	9.2	1.6	0.1106
Gain weight	-5.8	15.9	-0.36	0.7166
Stay the same	0.0	.	.	
Grade				
7th grade	-10.2	7.6	-1.34	0.1791
8th grade	0.0	.	.	
Health Status				
Excellent health	6.2	15.2	0.41	0.6835
Very good health	0.7	15.2	0.04	0.9646
Good health	-5.7	15.4	-0.37	0.7099
Fair health	0.0	.	.	
Gender				
Boy	34.1	7.7	4.4	< 0.0001
Girl	0.0	.	.	
Resting Heart Rate	0.0	0.2	0.16	0.8765
Wear time	0.3	0.0	25.8	< 0.0001

Table 3. Regression model testing winter and weekend differences in moderate and vigorous physical activity minutes as the outcome.

	Estimate	Std. Error	t-value	p-value
Winter	765.7	179.4	1792	< 0.0001
Weekend	779.5	7.3	0.148	< 0.0001
Winter & weekend	140.1	209.7	0.670	0.5041
Weight Change				
Lose weight	329.0	344.2	0.96	0.3393
Gain weight	-182.8	595.3	-0.31	0.7589
Stay the same	0.0	.	.	
Grade				
7th grade	384.7	282.1	1.36	0.1729
8th grade	0.0	.	.	
Health Status				
Excellent health	654.6	575.6	1.14	0.2556
Very good health	455.1	572.5	0.79	0.4268
Good health	375.3	585.7	0.64	0.5217
Fair health	0.0	.	.	
Gender				
Boy	1439.3	291.6	4.94	< 0.0001
Girl	0.0	.	.	
Resting Heart Rate	-24.8	11.5	-2.15	0.0317
Wear time	40.9	0.5	75.97	< 0.0001

DISCUSSION

This study aimed to observe the physical activity of children on weekdays versus weekends and school day weeks versus break weeks during COVID-19 to understand the structured day on children's physical activity levels. We found that adolescents were

significantly more active during regular school days than weekend or winter breaks during COVID. This is important because many children became significantly less active during the pandemic when schools and other community facilities were shut down. Despite the fact that there has not been as much research on weekday and weekend comparisons during COVID-19, an article written early on in the pandemic concluded, “Short-term changes in PA and SB in reaction to COVID-19 may become permanently entrenched…” (Dunton, 2020) When comparing the physical activity levels in children during school and outside of school, children were overall much more active during the weekdays during school than time spent outside of school such as weekends and breaks. Step count is decreased by about 50% during weekends and breaks while MVPA decreases by about 40% in children (Dunton, 2020). These findings emphasize the effects of a structured day on children, especially during COVID-19.

The results we see from observing the physical activity levels in children during the week compared to the weekend suggest that structured days influence children to be more physically active. Data on physical activity levels on weekday versus weekend days has been limited and studies that exist have been limited by small sample sizes and the time of data collection. There are several reasons why children may be more inactive during the weekend days. First, the lack of the necessity to leave the house removes any activity children could have gotten from simply getting to school. Second, the structured day from school enables children to get out and participate in activities that they otherwise would have not had they remained home. And finally, the absence of parents on the weekend could also negatively affect their child’s health. According to the findings from one study, family social events have a heavy impact on children’s physical activity levels (McMinn, 2013).

We observed that children had a sharp decrease in physical activity and step count during the winter break. Despite this, there is a lack of research on how winter break affects the health

of children across the United States. The holiday season is a significant time to monitor children's health due to the winter break from school, weather, increase in consumed sweets, and activity trends that occur from the festivities. We already understand that adults display an increase in weight during the holiday season making it crucial for us to observe the effects on children as well. Weight gained from the holiday foods could be detrimental to a child's health as it could lead to obesity and other negative health conditions. Winter breaks differ from summer break for two main reasons. In most areas of the United States, the holidays occur during the cold winter months. Children who are already on break from school often remain inside their homes for the entire duration of their break. An increase in one-degree Celsius was associated with 26 more steps a day. During heavy precipitation, steps were decreased by 1,022 steps per day. These findings were more relevant on non-school days than school days (Rahman, 2019). The second difference is that many parents are home with their children during this break as opposed to the multiple-month-long summer break. Because of this, it is important for parents to take the opportunity to intervene and assist their children in reaching their physical activity requirements.

More studies have been done on the effect of summer break on children's physical activity due to its long duration. Although our study observed the effects of winter break on the students, it can be helpful to look at how other breaks affected the physical activity of the students. Studies have shown that summer breaks could have negative consequences on the activity level of children, especially girls, (Salmon, 2015) where outdoor play may be inconvenient to the children. One article cites that physical activity drops by 18% in nine-year-old children during the summer vacation (Volmut, 2020). The key difference between summer days and weekend days is the duration of the less-structured environment. During the summer break, most parents are still working. This could have negative outcomes on children's activity

levels as they may not have means of leaving their house. Summer programs by local communities or their school can be important in keeping children active during the summer.

On average, boys spent significantly more time active than girls when comparing average step count and MVPA. Studies have shown that as students enter their teenage years, MVPA decreases and sedentary behavior increases, especially in girls (Fu, 2016). In other studies, vigorous physical activity, moderate physical activity, and low physical activity were specifically measured. Boys were observed to have greater VPA while girls engaged more in LPA. Girls also were shown to have greater sedentary time (Bailey, 2012). Our findings were consistent with these. It may be beneficial to have interventions that specifically target girls.

There are several limitations of this study. First, the sample for this study was small and not very diverse. The majority of the participants were Caucasian. This means that the data may not be as accurate of a representation. Students were asked and encouraged to wear their Fitbits for all waking hours. However, because of their age, wearing the Fitbit consistently may have been too much of a burden. This could have led to inconsistencies in our data.

CONCLUSION

Overall, middle school students were more active during the school weeks compared to during the winter break weeks. Similar patterns are shown in girls and boys when comparing activity levels in school days and weekend days. Regardless of whether it was structured or unstructured days, boys were overall more active than girls. This study highlights the importance of the structured day from school. Interventions are important to promote physical activity levels for adolescents during non-structured days such as weekend and school breaks.

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