An Exploratory Study of Seasonality and Preschoolers’ Physical Activity Engagement


Background: While there is an emerging body of literature showing variations in physical activity between seasons, further investigation is needed to better understand this association in preschool-age children. This study was designed to examine seasonal variation from fall to winter in physical activity among preschoolers.

Methods: Forty-six preschool children from 2 preschools in a large Midwestern Metropolitan area completed weekly habitual physical activity measures in both fall and following winter. The habitual physical activity was quantified with the GT1M Actigraph uniaxial accelerometer. To determine seasonal differences in physical activity, a series of paired sample t tests were conducted.

Results: Although overall physical activity level declined in winter, the magnitude of seasonality effects seem varied in terms of contexts. Compared with the decline during after-school time and during weekends, the differences in physical activity across the 2 seasons were much less evident during the time attending preschool and during weekdays.

Conclusion: Seasonality in physical activity can be moderated by other contextual factors, such as preschool policies and curriculum. Preschools may serve as a major battlefield for fighting against physical inactivity and obesity during childhood due to their practical controllability.

Keywords: health behavior, gender, accelerometry

Childhood obesity has reached almost epidemic proportions and is emerging as a public health crisis in the United States. Overweight and obesity are especially of concern among the preschool population. Recent data show that 10.4% of children aged 2–5 years are considered obese and 21.2% considered overweight. The increasing prevalence among this age group indicates that prevention activities need to begin during the preschool years.

One important aspect of childhood obesity prevention includes efforts to increase physical activity. There are many risk factors that influence physical activity behavior ranging from child level factors, to family, community, and cultural level factors. Individual child risk factors include physical-specific factors, such as activity choices, physical activity ability, and relevant knowledge. Potential family influences include parents’ attitudes and behaviors regarding exercise, exercise preferences and knowledge, and parental monitoring of sedentary behavior. Characteristics of the community include access to facilities, neighborhood safety, and the availability and opportunities for exercise.

Cultural factors include cultural norms for exercise preferences/choices and ideal body image. However, compared with these variables, factors related to the natural environment, such as seasons and weather, have received much less attention as determinants of physical activity, especially in preschoolers.

Researchers have explored possible weather-related factors contributing to seasonality. It is found that temperatures and daylight time in different seasons are related to physical activity level. Children living in cold climates are less likely to be physically active in the winter. Carson et al. examined seasonal differences in physical activity levels among Northern Canadian children. By using parent-report questionnaires, they reported that children were significantly more likely to be physically active in the spring and summer and somewhat physically active in the fall, relative to winter. Beighle, Alderman, Morgan, and Masurier investigated the impact of season on the pedometer-determined physical activity levels of elementary school students and found that both boys and girls were more active during spring than in winter. Similar results were found in Fisher et al. However, others found no seasonal differences in daily step counts or in proportion of time spent in vigorous physical activity for preschool children in South Dakota.

While there is an emerging body of literature showing variations in physical activity among seasons, further investigation is needed to better understand this association in preschool-age children. More specifically, there are 3 pressing research questions that need to be
addressed. First, is seasonality associated with preschoolers’ physical activity engagement in the same manner during school and after school? Previous studies have measured overall physical activity but very few have specified physical activity variation in different contexts. With over 13 million U. S. children attending preschools and half of their calories consumed outside the home, preschooless are uniquely situated to combat the disturbing trend of childhood overweight and obesity. Understanding the seasonality in preschoolers’ physical activity in terms of participation status in school is critical. We conjecture that the impact of seasonality in physical activity may vary in terms of in-school and after-school settings.

Another key research question is whether seasonality is associated with preschoolers’ physical activity engagement in the same manner during weekdays and weekends. Given that habitual physical activity patterns are likely to be different between weekdays and weekends, we believe that seasonality may affect preschoolers’ physical activity engagement in terms of the weekday differences. Examining seasonal variation in physical activity based on weekdays will facilitate understanding of preschoolers’ physical activity patterns and support potential effective interventions.

A third research question of interest is whether there is a gender difference in the association between seasonality and physical activity. Researchers have found that boys and girls may have different physical activity level, starting as early as preschool age. Young girls usually participate in significantly less physical activity than boys. It is not known whether seasonality is differentially associated with very young girls’ and boys’ physical activity levels.

With these concerns in mind, we designed this exploratory study to examine the association between seasonality and preschoolers’ physical activity engagement through fall and winter. Specifically, we compared the variation in physical activity during 2 seasons, fall and winter, between in-school and after-school settings, and between weekdays and weekend days. Due to young children’s lack of cognitive ability to recall details of their physical activity and evident advantages of using objective approach to monitoring free-living physical activity in young children, we used accelerometry to measure and describe preschoolers’ physical activity engagement in this study. It is worthwhile to note that physical activity patterns might change continuously with the variance of climate. Follow-up with multiple seasons throughout a year would be preferred for a better understanding of seasonality.

Methods

Participants

This study was conducted in 2 preschools randomly chosen from a pool of preschools in a large Midwestern Metropolitan area. In addition to student demographic representativeness, 2 criteria were used to establish the pool of schools: a) the schools are full-day programs for children 3–5 years of age, and b) curriculum should be in line with state standards providing developmental education for different aged children. The student body at the 2 schools was ethnically and socioeconomically diverse with parental backgrounds ranging from low to upper-middle class. The sample was representative of the ethnicity demographics for the student population (68% Caucasian, 32% Minority). The curriculum and routine at the 2 schools were basically identical following the State guideline and regulation. Despite some differences in physical space conditions, both schools had updated outdoor areas with play structures available. All 103 parents of the 3- and 4-year-old children were invited to enroll their children in this study. Seventy-seven (75%) parents or guardians provided informed consents. Permission to conduct the study was obtained before the investigation from the institutional review boards.

Due to limited availability of accelerometers, a sample of 30 children in each school (N = 60 in total) was selected for the study by simple randomization. Complete data in the fall were obtained for 55 of the 60 children. After being followed over a semester, among the 55 participants, 9 were excluded from the final sample in the winter either because they relocated or because their data were incomplete. The final sample consisted of 46 preschool children (boys = 20; girls= 26).

Weather Data

The preschools are located at 42.4-degree latitude and 83.2-degree longitude (2011, weather.gov). The climate is warm during summer, with average temperatures in the 70s degrees Fahrenheit, and cold during winter, with temperatures tending to be in the 20s degrees Fahrenheit. During the fall data collection in October, the mean temperature was 53.8 degrees Fahrenheit while the mean temperature during the winter data collection in February was 28.9 degrees Fahrenheit.

Variables and Measures

Demographic Characteristics. Children’s height and weight were obtained in both fall and winter. Specifically, body weight was measured without outer coats and shoes, using a portable digital scale (Tanita Model BC551). Two measures were obtained. The average of the 2 readings (within 0.1 kg of each other) was used as the body weight. Body height was measured, without shoes, using a portable stadiometer (Seca 214, Seca North America East, Hanover, MD). Two readings were recorded. If the difference was more than 0.2 cm, a third measure was taken. The average of the 2 readings within 0.2 cm of each other was retained. In addition, data on child’s sex, age, and race were obtained via baseline surveys completed by parents.

Physical Activity Engagement. The habitual physical activity of each child was quantified with the GT1M
Actigraph (Pensacola, FL) uniaxial accelerometer (formerly known as the Computer Science and Applications 7164). The GT1M actigraph is small (3.8 × 3.7 × 1.8 cm), lightweight (27g), and unobtrusive to wear. Accelerometers were attached to adjustable elastic belts and worn over the right hip. Following Nilsson et al’s suggestion, a 15-second sampling interval was set. According to the recommendation regarding the number of monitoring days for habitual physical activity in children, parents of the participants were asked to fit the accelerometers on their children for a period of 6 consecutive days starting on Tuesdays. To diminish the influence of possible behavior change due to the novelty of wearing an accelerometer, we deleted data collected during the first day. As a result, data were collected over a 5-day period, including 3 weekdays and 2 weekend days. Data obtained between 7:00 AM and 8:00 PM were considered as monitoring time for analysis.

A trained graduate student instructed parents on proper accelerometer use during a workshop before each formal data collection. Parents were asked to have their child wear the accelerometer during waking hours and removing it only for water-based-activities and sleeping. They were also given an information letter including instructions and a form for reporting the starting and ending times of accelerometer use daily and arriving and leaving time of preschool during weekdays. Preschool teachers were also instructed on accelerometer use so that they could address any problems with the accelerometers during the school day.

Data Reduction

Activity counts for each 15-second interval over the monitored time were uploaded through ActiLife Data Analysis Software. The raw output was reported to provide a measure of total physical activity. To analyze the amount of time children spent at different intensity levels, we used the separate cut-off counts developed by Sirard, Trost, Pfeiffer, Dowda, and Pate for 3- and 4-year-olds. Specifically, sedentary activity was defined as the cut-off counts per 15 seconds less than 302 for 3-year-olds and 364 for 4-year-olds; light activity as the counts between 302 and 614 for 3-year-olds and between 364 and 811 for 4-year-olds, moderate activity as the counts between 615–1230 for 3-year-olds and between 812–1234 for 4-year-olds; and vigorous activity as the counts 1231 or more for 3-year-olds and 1235 or more for 4-year-olds. The children’s data were aggregated and averaged to represent their physical activity level in terms of different contexts (ie, in-school versus after-school; weekdays versus weekends). To enable comparison with the literature, the amount of time children spent at the different intensity levels were displayed in minutes.

Statistical Analyses

Data were analyzed using SPSS for windows (version 17.0; SPSS Inc, Chicago, IL). Means and standard deviations were calculated for counts/minute (cpm) and time spent in different intensities to show the extent of activity in preschool children. One-way analyses of variance (ANOVA) were conducted to examine school differences in total physical activity. To determine seasonal differences in physical activity, a series of paired sample t tests were conducted. We set statistic significance at an α level of .01 to avoid possible equal variance assumption violation due to a small number of participants.

Results

The number of monitoring days for each data collection ranged from 3–5 days (Mean = 4.1 days; SD = 1.1 days) including at least 1 weekend day; the monitoring time for each day ranged from 8.1–13.0 hours (Mean =10.7 hours; SD = 2.0 hours). During a weekday, the average in-school monitoring time ranged from 5.1 to 8 hours (Mean = 6.8 hours; SD = 1.0 hours) while the average after-school monitoring time ranged from 3 to 5 hours (Mean = 3.9 hours; SD = 0.8 hours). Monitoring days and monitoring time for each day did not vary across the 2 seasons. In the fall, the participants’ age ranged from 3.75–4.41 years old (Mean = 4.15 years old; SD = .21 years) and their average Body Mass Index (BMI) ranged from 15.40 kg/m² to 20.17 kg/m² (Mean = 17.41; SD = 1.42). In the winter, the participants’ average age was 4.50 years old with average BMI of 17.81 kg/m². These values were within the normal ranges for children of this age.

Total physical activity, expressed as mean accelerometer counts/minute (cpm) was 767 cpm (SD = 89) for fall and 710 cpm (SD = 74) for winter. Based on the result in ANOVA, there was no significant difference in mean counts/minute by schools for either fall or winter. As such, data from both schools were combined together as a single data set for further analysis.

Means and standard deviations for time spent in light, moderate, vigorous, and overall light-to-vigorous physical activity by gender are shown in Tables 1 and 2. Paired t tests revealed interesting seasonal differences in time spent in varying physical activity intensity. In terms of time during school attendance, there was no difference in minutes of light, moderate, and vigorous physical activity between fall and winter for either girls or boys. However, in after-school time, significantly more minutes of light activity occurred in fall relative to winter for both boys and girls. In addition, girls spent more time in moderate physical activity and overall light-to-vigorous physical activity in fall than that in winter. In contrast, no differences in moderate and vigorous physical activity were observed in boys.

In terms of weekdays versus weekends, the seasonality on weekdays was not evident. There was no difference in minutes of light, moderate, and vigorous physical activity during weekdays. In contrast, during weekends, both girls and boys spent more time in light, moderate, and overall light-to-vigorous activity in fall than that in winter. However, there was no difference in vigorous physical activity for either girls or boys in fall relative to winter.
Table 1  Time Spent in Different Intensities of Physical Activity In-School Versus After-School

<table>
<thead>
<tr>
<th>Minutes per day</th>
<th>Girls (n = 26)</th>
<th>Boys (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall Mean/SD</td>
<td>Winter Mean/SD</td>
</tr>
<tr>
<td>In-school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>66.18/37.07</td>
<td>67.65/26.34</td>
</tr>
<tr>
<td>Moderate</td>
<td>17.76/10.92</td>
<td>18.25/10.76</td>
</tr>
<tr>
<td>Vigorous</td>
<td>4.30/4.30</td>
<td>5.01/5.95</td>
</tr>
<tr>
<td>Light-vigorous</td>
<td>88.24/39.60</td>
<td>90.91/33.15</td>
</tr>
<tr>
<td>After-school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>40.30/20.96</td>
<td>28.59/14.21</td>
</tr>
<tr>
<td>Moderate</td>
<td>11.43/11.68</td>
<td>8.53/7.13</td>
</tr>
<tr>
<td>Vigorous</td>
<td>2.88/2.39</td>
<td>2.09/2.05</td>
</tr>
<tr>
<td>Light-vigorous</td>
<td>54.61/25.99</td>
<td>39.21/19.79</td>
</tr>
</tbody>
</table>

Abbreviations: SD = standard deviation.
* P < .01.

Table 2  Time Spent in Different Intensities of Physical Activity on Weekdays Versus Weekends

<table>
<thead>
<tr>
<th>Minutes per day</th>
<th>Girls (n = 26)</th>
<th>Boys (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall Mean/SD</td>
<td>Winter Mean/SD</td>
</tr>
<tr>
<td>Weekday</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>106.48/57.10</td>
<td>96.24/41.24</td>
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<tr>
<td>Moderate</td>
<td>29.19/14.23</td>
<td>26.78/13.77</td>
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<tr>
<td>Vigorous</td>
<td>7.18/6.62</td>
<td>7.10/7.01</td>
</tr>
<tr>
<td>Light-vigorous</td>
<td>142.85/62.11</td>
<td>130.12/42.5</td>
</tr>
<tr>
<td>Weekend</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>103.32/57.42</td>
<td>82.27/38.97</td>
</tr>
<tr>
<td>Moderate</td>
<td>32.40/17.91</td>
<td>24.13/14.12</td>
</tr>
<tr>
<td>Vigorous</td>
<td>8.79/7.14</td>
<td>6.71/6.54</td>
</tr>
<tr>
<td>Light-vigorous</td>
<td>144.51/59.77</td>
<td>113.11/46.7</td>
</tr>
</tbody>
</table>

Abbreviations: SD = standard deviation.
* P < .01.

**Discussion**

The purpose of this study was to examine the association of seasonality with objectively measured physical activity levels in preschoolers. This study extends an emerging body of literature examining how seasonality is associated with preschoolers’ physical activity engagement. The findings in this study may help researchers and practitioners design specific and effective intervention strategies targeting physical inactivity in this age group. Consistent with Beighle et al11 and Carson et al,10 this study lends support to the statement that multiple measurements across different seasons throughout the year are needed to reflect accurate habitual physical activity in preschoolers.

Our findings revealed that there was an overall low physical activity level among preschool age children. Although the total physical activity while wearing an accelerometer in fall was statistically higher than that in winter, the mean number of minutes of moderate to vigorous physical activity of preschoolers were less than 45 minutes per day for both seasons. According to the National Association for Sport and Physical Education guidelines, preschool-aged children should accumulate at least 120 minutes of physical activity per day with both structured and unstructured physical activities. The
results indicate that the preschoolers might have different opportunities for physical movement due to weather changes but the actual intensity of physical activity was low for achieving sufficient health benefits. This finding is similar to research by Carson et al.\textsuperscript{10} and Fisher et al.\textsuperscript{9} showing that preschoolers should increase physical activity levels across seasons.

Nevertheless, seasonality appears to be one of the factors influencing preschoolers’ physical activity in the broad ecological system of health enhancement.\textsuperscript{25} Paired t tests revealed there was no significant difference in minutes of light, moderate, and vigorous physical activity during the time children were attending the schools between the fall and the winter. As shown in Table 1, with approximately 7 hours of preschool attendance, girls and boys engaged in MVPA for only 22.10 minutes and 26.17 minutes per day, respectively, in fall, and 23.26 minutes and 25.75 minutes per day, respectively, in winter. The impact of seasonal variation on preschoolers’ in-school physical activity seemed limited.

We contribute this finding to the schools’ practices and policies. Based on our observation and interviews with the teachers during both seasons, we found that seasonal variation had rarely influenced the teachers’ lesson plan and class routine. There were no requests or resources in the preschool curriculum stressing ways to integrate activity limitations due to seasonality with instruction that would provide strategies and other opportunities for children to engage in moderate to vigorous physical activity. Finn, Johannsen, and Specker\textsuperscript{12} argued that school policies and practices directly impact the overall physical activity levels of young children in the United States. Our findings support this conjecture. To some extent, school policy and curriculum can override seasonality in physical activity engagement during the time attending schools.

On the other hand, we found that there were significant seasonal differences in physical activity during after-school time for both girls and boys. As shown in Table 1, girls’ and boys’ after-school MVPA dropped by nearly 3.5 minutes from fall to winter. In terms of physical activity, both boys and girls were significantly more engaged in light physical activity after school during the fall than in the winter. Seasonality played a role in this variation. The first possible seasonal factor is weather. As previously reported, this area has freezing temperatures (below 30 degrees Fahrenheit in average) with snow accumulation in winter, which could have made it difficult for outdoor physical activity. Parents might be reluctant to allow their children stay outside for long periods of time due to concerns about physical health in cold weather. The second possible seasonal factor was daylight time. Compared with fall, daylight time in winter is much shorter. Consequently, children had fewer hours of daylight to be active. Given these 2 factors, we assumed that seasonality might have had both direct (eg, changing physical activity environment) and indirect (eg, leading parents to worry about their children’s health and safety) effects on preschoolers’ overall physical activity engagement after school.

After-school vigorous physical activity engagement was unchanged in winter from fall. The amount of after-school vigorous physical activity was low in both seasons. The difference of the time spent in vigorous physical activity between fall and winter was less than 1 minute for both girls and boys, suggesting that seasonal change or daylight hour variation had negligible impact on children’s high-intensive physical activity. This result might contribute to the nature of sporadic and unstructured physical activity after school. It is likely that due to the lack of structure and facilities, young children could not initiate and elevate their physical activity to a vigorous level. In addition, it is possible that vigorous activity after school is limited by parent rules or increasing “screen time” of TV and computer-based activities. Future research is needed to further address this issue.

Physical activity engagement during weekdays was not associated with seasonality. For both girls and boys, their physical activity engagement in light, moderate, and vigorous level in fall was similar with that in winter. The result is not unexpected given that the majority of children’s nonsleeping time is spent in the preschool setting and there was a low variation in physical activity across seasons in the preschools. However, during weekends, seasonality on light and moderate physical activity level was evident. Girls and boys engaged in more light and moderate physical activity during fall than they did during winter, indicating the seasonal effect in physical activity was more evident during weekends.

It is worthwhile to note that although there was no difference statistically in physical activity engagement between boys and girls, the pattern of differences, as shown in Tables 1 and 2, revealed that girls were less active than boys, regardless of season. This finding is consistent with previous studies.\textsuperscript{18,26} We speculate that gender differences in playing styles might lead to girls’ participating less in physical activity. Hoffmann and Powell\textsuperscript{27} suggested that boys like to play in larger groups, engage in more risk-taking behavior, and play rougher games involving greater amounts of body contact than do girls. Alternatively, girls may receive less encouragement from teachers and parents to engage in physical activity during and after the preschool day. Our exploratory study findings suggest this trend may extend to preschool boys and girls, as well. Due to our small sample size, we are unable to generalize these results. Further research is needed to explore the gender differences in preschoolers’ physical activity engagement and its association with seasonality.

This study had limitations that should be noted. First, the data were collected in a single, large Midwestern Metropolitan area. Although the sample was representative of the racial/cultural characteristics and socioeconomic status in the participating schools, we are not able to generalize the conclusions beyond the current population. Second, due to relatively homogeneous age group in the
sample (the age difference was less than 8 months), we did not examine the influence of age on physical activity involvement. Future study may take age factor into consideration when investigating seasonality in preschools. Third, due to limited budget and the lack of instruments, we were unable to conduct this study with relatively large sample size and multiple schools sites. Future research can improve upon this study by extending sample size and sites and associating other relevant factors, such as teacher characteristics, school characteristics (ie, social and environmental factors), and parents’ physical activity levels, with children’s physical activity behavior. Fourth, evaluation of preschoolers’ physical activity engagement will not be explained effectively without consideration of the context (eg, weather, setting, location, and format) in which they are embedded. In addition to objective measures, other assessment tools, such as observation, teachers’ and parents’ reports, should be included in future research to better understand preschoolers’ mode and duration of various physical activities in different seasons. Last, as we addressed in the introduction, data collection times in this study were limited to fall and winter. It is likely that preschoolers’ behavior patterns might be characterized differently in other seasons (ie, spring, summer). Future research should accommodate all seasons throughout a year.

**Conclusion**

By using accelerometry to measure physical activity across 2 seasons, we found preschoolers’ overall physical activity level was lower than the recommended national guidelines. Activity levels, especially moderate and vigorous, within our sample were lower yet during winter compared with fall, indicating there is a seasonality effect on children’s physical activity engagement. Although there was a significant decline in physical activity level during afterschool and during weekends in winter, seasonality in physical activity during the time attending school and weekdays was very limited.

Given students’ relatively stable physical activity engagement while attending schools across seasons, preschools may be a major battlefield for fighting against physical inactivity and contributing much to obesity prevention efforts during childhood due to their practical controllability. With available space, facilities, and certified teachers, preschools can provide the core through which children can participate in planned and spontaneous physical activities and develop motivation and passion for lifelong physically active living. Dowda, Pate, Trost, Almeida, and Sirard\(^2\) suggested that preschools provide daily structured physical activity programs for enhancing physical activity of moderate to vigorous intensity. Professional training courses for future preschool teachers and continuing preschool teacher education programs should create awareness and incorporate effective curriculum and intervention strategies to increase physical activity level. Preschool teachers and parents not only need to understand the importance of physical activity, but also know how to encourage and actively teach the children to decrease sedentary behavior and promote physical activity regardless of seasonal conditions.

Our findings also suggest that with lower physical activity level outside of school in winter as compared with fall, designing effective strategies to increase preschoolers’ physical activity engagement in cold weather becomes critical. Given the outdoor environmental constrains in winter, home-based physical activity is essential. It is important for parents to understand, model and encourage healthy activity-based behaviors for their children at home. Future interventions should address parental awareness of the need and methods for home-based physical activity education program to practice of positive parenting behaviors and increase their children’s activity level. Our research confirms the need for effective physical activity modeling, monitoring, and need to set limits of sedentary behavior to enhance preschoolers’ physical activity engagement at home.\(^2\)

**References**


