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Physical Activity during Indoor and Outdoor Free Play in Toddlers

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ABSTRACT

Limited research has been conducted looking at physical activity levels in young toddlers in a childcare setting. Purpose: To assess physical activity levels indoors (in the classroom) and outdoors (on the playground) in toddlers aged 1 to 2 years old. Methods: Eight young toddlers (2.3±0,3y) from a single classroom at a university child development laboratory school were enrolled in the current study. Physical activity was assessed using three ActiGraph GT3X+ accelerometers that were worn on the right hip and each of the wrists. Each child wore the accelerometer during four trials two indoor and two outdoor), during unstructured free play. The trials were approximately 22 minutes in duration and accelerometer data (vector magnitude, counts per 15 seconds) were average for each environment (indoor and outdoor). A 2X3 repeated measures ANOVA was run to determine whether there were differences in environment (indoor versus outdoor) and accelerometer location (left wrist, right wrist, and right hip) or if an interaction existed. Results showed no difference in activity indoors versus outdoors (p= 0.624). There was a significant difference between the hip and left wrist (p=0.001) but no differences in the right wrist compared to the hip or left wrist (p-0.112). There was not a significant interaction between environment and accelerometer location (p=0.804). Conclusion: It appears that toddlers are equally active indoors and outdoors during free play and that they typically engage in activity that uses their arms and upper body.

INTRODUCTION

The number of children under 5 years old in the United States that are classified as overweight or obese are tripled since the 1970s (Trost 2012). According to the 2007-2008 National Health and Nutrition Examination Survey (NHANES), 21% of children between the ages of 2-5y are classified as overweight or obese. A crucial way to improve these statistics, is beginning adequate physical activity (PA) in toddlers.

PA is just as important for toddlers (12-36 months) as it is for adults. The National Association for Sport and Physical Education (NASPE 2006) recommend that toddlers should have at least 30 minutes of structured PA per day, and at least an hour and up to several hours of unstructured PA throughout the day. Toddlers should not be sedentary for more than 60 minutes excluding sleep. It is important for toddlers to mature their movement skills, in order to accomplish more difficult movement skills in the future. The indoor and outdoor areas where toddlers are physically active should be up to safety standards for performing large muscle activities. For the toddler to meet or exceed these guidelines, it is imperative that anyone responsible for the toddler knows the recommendations and their importance. For the child to obtain this suggested amount of daily PA, these recommendations should be enforced at home and at any childcare setting.

The current study will focus on young toddlers, age 1-2 years old. It is recommended that toddlers spend most of their day in unstructured free play (NASPE 2006). Although more research is needed on the complete benefits of unstructured play, it has been proven to be valuable to a child's development and skill set (Physical Activity 2013). Unstructured play can help strengthen problem solving capabilities,

understanding the viewpoints of others, the ability to take on the perspective of another, and the ability to get on with other (Physical Activity 2013). Free play is crucial for development of a healthy brain in children (Ginsburg et al., 2007). Free play requires the child to use their imagination and make sense of the world around them. By using their imagination, the child develops dexterity and physical, cognitive and emotional strength (Ginsburg et al., 2007). From a physiological standpoint, free play transforms the neurons in the prefrontal cortex of the brain (Hamilton et al., 2014). The prefrontal cortex corresponds with the emotional, physical and cognitive strength that requires imaginary skills (Frost et al,. 1998).

According to Rowlands and Eston, measuring PA in children, especially toddlers, can be difficult because it consists of frequent short bouts of activity. There are many methods that can be used to assess PA in young children including: heart rate, pedometry and accelerometry. The current study used accelerometers, which measure movement objectively and directly (Rowlands et al., 2007). Accelerometers are able to quantify intensity level, the amount of time spent in each intensity level, and the volume of activity and are believed to be an excellent device for measuring PA in free-living toddlers (Cauwenberghe et al., 2011). A 2012 study, examined the cut points for sedentary (SED), light physical activity (LPA), and moderate-to-vigorous physical activity (MVPA) in children and attempted to set cutpoints for toddlers under three years old by using accelerometers and coding activity. PA was assessed using direct observation coded as lying down/sitting, walking at an easy/slow pace, walking at a fast pace, and running (Trost et al., 2012). As a result of this study, it was recommended that cut points that had been previously established (Pate et al., 2006) be used for

cutpoints for both preschoolers and toddlers. These cut points have been established for the hip but not for wrist-worn accelerometers. The use of vector magnitude eliminates the use of cut points and allows for the measure of PA in multiple planes.

The benefits of outdoor play are copious and well-studied. Outdoor activity has been proven to increase fitness levels, Vitamin D levels (helps with bone strength, heart disease, diabetes, etc), decreases chances of nearsightedness and ADHD, improves critical thinking skills and performance in the classroom, and decreases stress (Tremblay et al., 2015). Although outdoor play may be a beneficial way for toddlers obtain PA, indoor play is also important to consider. Children spend the majority of their time indoors and outdoor play is not always feasible (weather, other children using the outdoor space). Indoor play can be an alternative for, or an addition to, outdoor play. Indoor play promotes creative and imaginative flow and toddlers are more likely to be creative during indoor play (IPEMA 2016). Both indoor and outdoor play have their pros and cons; however, together they are essential to the growth and development of the toddler.

Most activity toddlers engage in is gross motor activity. Gross motor activities are necessary for the development of motor competence and advanced motor skills (Stodden et al., 2008). They may also help toddlers reach the recommended daily activity guidelines. Some research has shown that preschool children tend to be more active outdoors (Raustorp et al., 2012, Schlechter et al., 2017). However, this area has not been well researched in toddlers (Trost et al., 2012). The current study aims to look at the activity levels and associated behaviors indoors (in the classroom) and outdoors (on the playground).

METHODS

Study Design

This cross-sectional study was designed to assess the PA levels of toddlers inside the classroom and on the playground. Prior to subject recruitment and data collection, IRB approval was granted and parental permission and child assent were obtained.

Setting

The study took place at a university-based child development lab school that focuses on nature-based learning. There is a natural playground for the toddlers and open free play areas indoors. Inside of the classrooms are numerous nature-like decorations and toys to emulate the outdoors. The school enrolls children from birth through kindergarten.

Participants

Participants were 8 children (3 boys; 2.3 ±0.3 years old) enrolled in the young toddler classroom at the university-based child development laboratory school.

Protocol

Research was conducted during normal operating hours (8:00am-5:30pm), but did not interrupt the normal school schedule. Data were collected twice a day, once in the early morning during indoor free play time, and once again during the late morning outdoor free play time. The larger study was designed to look at the PA levels and play

behaviors of younger (1-2 years old) and older (2-3 years old) toddlers. For the purpose of this thesis, only the PA levels in the young toddlers will be analyzed and discussed.

Anthropometry

Each participant's height and weight was measured with light clothing and shoes off. Height and weight were used to calculate Body Mass Index (BMI;$kg \bullet m^{-2}$).

Accelerometry

The Actigraph GT3X+ accelerometers were used to assess PA. The accelerometers were placed above the crest of the right iliac spine, and on the left and right ulnar styloid. The ActiGraphs were set to collect raw data at 30Hz. Student research assistants placed the three accelerometers on each child, and removed them when each assessment was completed.

To quantify PA, vector magnitude is often used. Vector magnitude signifies the square root of three axes (each squared), and is represented by ($\sqrt{(x^2+y^2+z^2)}$) (ActiGraph Corp.; Pensacola, FL). By measuring in three planes (x, y, and z) researchers may look at measurement of ambulation as well as movements outside of the vertical plane. In young children, especially toddlers, this is necessary due to their sporadic movement patterns and since validated cut points for the wrist have not been established in this population. Accelerometer data (vector magnitude; counts per 15 seconds) were averaged for the indoor and outdoor sessions for data analysis.

Free Play Assessment

Each child wore the accelerometer a maximum of once per day (either indoors or outdoors) for approximately 22 minutes. The total time for each child in the study was about 90 minutes spread across four days. The toddlers were assessed twice in the classroom and twice in the playground in a randomized order while wearing the three accelerometers (one on the right hip and one on each wrist) to objectively monitor their PA

Statistical Analysis

SPPSS (IBM, Inc.) software was used to analyze the data. Means and standard deviations of the anthropometric data were determined. A 2X3 repeated measures ANOVA was run to determine the differences between environment (outdoor vs. indoor) and the location of the accelerometer on the body (left wrist vs. right wrist vs. right hip) as well as a possible interaction between the environment and accelerometer location. The alpha level was set at $p<0.05$. Post-hoc analyses were used to detect differences amongst groups.

RESULTS

Eight young toddlers (3 boys, 5 girls) from one of the toddler classrooms in university child development laboratory school participated in this study. They were 2.3 $\pm$0.3 years old, weighed 14.3 $\pm$2.3kg, stood at 89.3cm $\pm$5.2cm tall, and had a BMI of 17.8$\pm$1.8 $kg \cdot m^{-2}$.

There was not a significant difference found between the classroom and playground vector magnitudes (p=0.624), meaning the children did an equal amount of activity in both environments during their free play time (Table 1). There was a significant difference between the hip and left wrist (p=0.001, Table 2); however, the right wrist was not significantly different from the hip or left wrist (p-0.112). There was not a significant interaction between environment and accelerometer location (p=0.804).

Table 1. Average vector magnitude (counts per 15 seconds) in the classroom versus the playground.

Environment	Mean	Std. Deviation
Playground	874.8	195.5
Classroom	836.6	201.6

Table 2. Average vector magnitude (counts per 15 seconds) at each accelerometer site.

Accelerometer Sites	Mean	Std. Deviation
Left Wrist	1081.594	211.2
Right Wrist	895.375	318.2
Right Hip	590.075*	255.5

*Left wrist was significantly different from the hip.

DISCUSSION

When looking at outdoor play versus classroom play, there was not a significant difference between the two. These findings show that in this sample, the children did the same amount of activity in the playground as compared to the classroom. We found a significant difference in the hip and left wrist, but data comparison involving the right

wrist was not significantly different from either the hip or the left wrist. These findings show that children may do more activity using their arms compared to doing activity that involves movement from one place to another, for example walking or running.

PA for toddlers is just as important, if not more, as is it for adults. Establishing a physically active lifestyle young, can make carrying PA into adulthood easier. It is also a key factor in developing both fine and gross motor skills. Motor skills are important and necessary for future sport participation, and many lifelong leisure activities (bicycling, golfing, tennis, etc.). Being physically active throughout childhood, will help development, and also start to lower the chances of being at risk for certain diseases and disorders associated with adiposity and obesity (Freedman 2001).

Due to the fact toddlers were studied in this research project, there are multiple reasons that can explain the insignificant difference in classroom and playground play. At 1-2 years old, toddlers are just learning to walk and run. Because of this, they may not be as active as older children, even when outdoors. The toddlers observed partook in activities such as listening to a book being read, observing teachers, sitting and playing in dirt or sand, picking up things such as sticks, pebbles or buckets, or following someone around.

Another factor may be the space used. In the childcare center we studied, the children were free to roam inside as well as outside. The inside space was large and the toddlers were able to run around and play freely, just as they would outdoors. Other childcare centers should consider having a large, open space indoors for the children to play and obtain PA. Another possibility for the insignificant difference is the size of the outdoor area. If there is insufficient space, or the area is hard to move around in, this

could affect the level of PA. In the case of our study, the childcare center had a dedicated outdoor play space, but when multiple classes were outside, the space became too small for vigorous activity.

The differences between the left wrist and the hip are not to go unnoticed. The toddlers spent most of their free play time sitting or standing in the same area, and using their upper body to play. Examples of using the upper body inside the classroom include playing with cars or trucks, coloring, playing with baby dolls, etc. Outside of the classroom, the toddlers could be seen partaking in things like building things in the sandbox or with mud or sticks, painting, digging, etc. All of these activities involve little to no movement in the hip and a lot of wrist motion. The insignificant difference between the right wrist and hip may be explained by the right wrist accelerometer not functioning for some trials. We later discovered the malfunctioning right wrist accelerometer and switched it out, but unfortunately, it had been used on previous data collection days. Also, it is important to note that at this point in the child's development, hand dominance is not established, so the fact that there were not significant differences between the wrists support this finding.

Although there were many strengths to the study, there were also some limitations. One of the biggest strengths of the study was using an objective measure of PA (accelerometers). Another was that our research assistants did very well with not intervening with the toddlers and keeping everything as natural as possible for them. Data collection did not interrupt the daily classroom activities and the process was well-designed. Allowing the toddlers to test out and get used to wearing the accelerometers before data collection began was helpful for the research assistants and the toddlers.

This is a novel study that will add to the literature regarding toddlers and PA. If this study were to be done again, a limitation that could be corrected would be to have more accelerometers and make sure they are all accurate in collecting the data. We had three sets of accelerometers that could be used at a time, however if more accelerometer sets were available, more data could have been collected in a shorter amount of time. One of the biggest limitations was the small sample size. Since only eight toddlers participated in this study, this could have impacted our ability to find significance and results should be interpreted with caution.

In conclusion, there is potential for children to obtain PA that will contribute to daily recommendations during indoor free play time. Based on these results, childcare centers for toddlers ages 1-2 should look at the space they have provided for indoor and outdoor play and make sure it is sufficient for children to move around freely. Centers should also ensure that toddlers have adequate amount of space to obtain activity to meet the recommendations. In line with PA recommendations, childcare centers should give toddlers plenty of opportunities for free play throughout the day. If the toddlers are not achieving the recommended amount of daily PA during unstructured play time, teachers should be encouraged to assist the toddlers in reaching that goal during structured indoor and outdoor play time. Since our data show toddlers are most active using the upper body, providing toys and loose parts will allow children to continue engaging their upper body. As children develop their motor skills, more activity using the lower body can be incorporated.

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