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## **Compliance With National Guidelines for Physical Activity in U.S. Preschoolers: Measurement and Interpretation**

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# Compliance With National Guidelines for Physical Activity in U.S. Preschoolers: Measurement and Interpretation



**WHAT'S KNOWN ON THIS SUBJECT:** Physical activity plays an important role in the development of preschool-aged children (aged 3–5 years). Public health guidelines exist that specify a minimal level of physical activity preschoolers should accumulate daily. Previous studies conclude that the majority of preschoolers do not meet these guidelines.



**WHAT THIS STUDY ADDS:** Ambiguity in the interpretation of the guidelines, coupled with multiple ways to quantify physical activity, precludes definitive statements regarding the prevalence of sufficiently active preschoolers. Concerted attention is required for developing explicit guidelines and standardization of physical activity measures.

## abstract

**OBJECTIVE:** The National Association for Sport and Physical Education (NASPE) guidelines for preschoolers recommend 120 minutes of physical activity daily. Two issues, however, create a situation whereby substantial variation in estimated prevalence rates of (in)active preschoolers are reported. First, NASPE guidelines have been interpreted in multiple ways. Second, objective monitoring via accelerometry is the most widely accepted measure of preschoolers' physical activity, yet multiple cut points provide vastly different estimates of physical activity. This study aimed to estimate the prevalence of preschoolers meeting NASPE guidelines and illustrate the differences among rates, given guideline interpretations, and cut points.

**PATIENTS AND METHODS:** Three- to 5-year-old children ( $n = 397$ ) wore ActiGraph accelerometers for an average of 5.9 days. NASPE guidelines were expressed in 3 ways: 120 minutes daily of light-to-vigorous physical activity; 120 minutes daily of moderate-to-vigorous physical activity; and 60 minutes daily of moderate-to-vigorous physical activity. Estimates of 120 minutes daily of light-to-vigorous physical activity, 120 minutes daily of moderate-to-vigorous physical activity, and 60 minutes daily of moderate-to-vigorous physical activity were calculated on the basis of 4 common accelerometer cut points for preschoolers: Pate, Reilly and Puyau, Sirard, and Freedson.

**RESULTS:** Prevalence rates varied considerably, with estimates ranging from 13.5% to 99.5%, 0.0% to 95.7%, and 0.5% to 99.5% for 120 minutes daily of light-to-vigorous physical activity, 120 minutes daily of moderate-to-vigorous physical activity, and 60 minutes daily of moderate-to-vigorous physical activity, respectively.

**CONCLUSIONS:** The variation in NASPE guidelines, coupled with different accelerometer cut points, results in disparate estimates of (in)active preschoolers. This limits the ability to estimate population prevalence levels of physical activity that can be used to guide public health policy. Development of new guidelines should focus on an explicit delineation of physical activity and attempt to standardize the measurement of preschoolers' physical activity. *Pediatrics* 2011;127:658–664

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### KEY WORDS

moderate to vigorous, children, adolescents, benchmark

### ABBREVIATIONS

NASPE—National Association for Sport and Physical Education  
MVPA—moderate-to-vigorous physical activity

Dr. Michael W. Beets conceptualized the research question, analyzed the data, and drafted the manuscript. Mr. Daniel Bornstein and Dr. Marsha Dowda assisted with drafting the manuscript and interpretation of the analyses. Dr. Russell R. Pate contributed to the acquisition of the data and drafting of the manuscript.

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Health-enhancing physical activity during early childhood serves not only to entrench healthy behaviors throughout life<sup>1</sup> but also plays a role in developmental milestones, such as cognitive functioning, socialization, and emotional well-being.<sup>2,3</sup> The National Association for Sport and Physical Education (NASPE)<sup>4</sup> has developed nationally recognized physical activity guidelines for children from birth to the age of 5 years. These guidelines advocate for increasing opportunities for preschoolers (aged 3–5 years) to engage a minimum of 120 minutes of daily physical activity, with this activity coming in the form of 60 minutes of structured and 60 minutes of unstructured physical activity. Recent updates to the guidelines state that within these 120 minutes, caregivers should plan opportunities for preschoolers to engage in moderate-to-vigorous physical activity (MVPA). Other interpretations of the NASPE guidelines have focused on sufficient physical activity, which is defined as a minimum of 60 minutes of MVPA daily.<sup>5</sup>

A previous review<sup>5</sup> and three empirical studies<sup>6–8</sup> indicate that the prevalence of preschoolers meeting the NASPE guidelines ranges from 7% to 96%. These studies either interpreted the NASPE guideline as 3 or more hours of physical activity daily,<sup>6</sup> included measures of physical activity of low accuracy (eg, parent proxy reports),<sup>5,6</sup> or were based on samples outside the United States.<sup>6–8</sup> Likewise, the studies<sup>7,8</sup> that used objective monitoring of preschoolers' physical activity used 2 different, yet scientifically validated and accepted, ways to classify physical activity intensity. This is likely the reason behind the large difference in reported prevalence estimates. Objective monitoring (ie, accelerometry) is considered to be the most acceptable means to measure preschoolers' physical activity.<sup>9</sup> Yet 1 of the major issues

with objective monitoring, however, is the selection of cut points by which to quantify physical activity intensity. Studies indicate that different cut points can result in a 10-fold difference in physical activity estimates<sup>10</sup> and that sizable differences in the percentage of preschoolers accumulating 60 minutes of MVPA (75% vs 25%) are observed depending on the accelerometer cut points used.<sup>11</sup>

It is specifically this issue, coupled with the multiple interpretations of the NASPE guidelines, that makes it difficult to determine the extent to which preschoolers are meeting national recommendations for accumulation of daily health-promoting physical activity. If physical activity guidelines are established and compliance is monitored, their interpretation and measure require uniformity. Furthermore, there are no US-based estimates on the proportion of preschoolers meeting physical activity guidelines. The purpose of this study, therefore, was to describe the prevalence of preschoolers that meet the NASPE physical activity guidelines using multiple interpretations of the guidelines and how the prevalence estimates vary across different sets of widely used accelerometer cut points for classifying preschooler's time spent in physical activity of different intensities (ie, light-to-vigorous physical activity).

## PATIENTS AND METHODS

This is a secondary data analysis of an existing data set (the Children's Activity and Movement in Preschool Study) of 419 preschool children, aged 3 to 55 years, from Columbia, South Carolina. Recruitment and data collection procedures have been described in detail elsewhere.<sup>12,13</sup> These procedures are briefly reviewed here. The sample consisted of a majority of African American (51%) preschoolers attending 22 commercial, religious, or head-start

preschools from the greater Columbia, South Carolina, area and served children from a variety of different types of backgrounds, including urban, rural, and low and high socioeconomic status. None of the participants had any physical limitations that restricted their participation in physical activity. Physical activity data information were collected during 2 waves at each of the 22 preschools across a 28-month period (August 2003 through January 2006). The protocols of the Children's Activity and Movement in Preschool Study were approved by the University of South Carolina Institutional Review Board, and written informed consent was obtained from each child's primary guardian before collection of any data.

## Accelerometry

Physical activity in this study was measured by the ActiGraph accelerometer (ActiGraph model 7164; ActiGraph, Pensacola, FL). All data were collected using a 15-second interval (epoch). This accelerometer is designed to detect volume and intensity of physical activity. Time spent in physical activities of varying intensities is derived through the application of cut points developed to differentiate when preschoolers are engaged in sedentary (eg, sitting), light (eg, slow walking), moderate (eg, fast walking, skipping), and vigorous (eg, jogging, running) physical activity.<sup>14</sup> Optimal cut points were determined on the basis of a criterion measure of energy expenditure associated with physical activity intensity (ie, indirect calorimetry, whole-room calorimetry, or direct observation).<sup>14</sup> The 4 most common sets of ActiGraph accelerometer cut points to define time spent in sedentary, light, moderate, and vigorous physical activity in the preschool-aged population were identified from an extensive literature search. The cut points (see Table 1) were from Pate et al<sup>13,15</sup>, Reilly and

**TABLE 1** ActiGraph Accelerometer Cut Points Used to Define MVPA in Preschool-aged Children

Cut Point Source	Age, y <sup>a</sup>	Age Range, y <sup>b</sup>	Light Physical Activity, Counts per 15 s	MVPA, Counts per 15 s
Pate et al <sup>13,15</sup>	3–5	3–5	38–419	≥420
Sirard et al <sup>18</sup>	3	3–5	302–614	≥615
	4		364–811	≥812
	5		399–890	≥891
Freedson et al <sup>14,21</sup>	3	6–18	25–91	≥92
	4		25–110	≥111
	5		25–130	≥131
Reilly and Puyau et al <sup>16,17</sup>	3–5	3–4/6–16	275–799	≥800

<sup>a</sup> Age range in which the cut points were applied in this sample.

<sup>b</sup> Age range in which the original cut point validation/calibration study was conducted.

Puyau et al<sup>16,17</sup>, Sirard et al<sup>18</sup>, and the Freedson et al equation using 3 metabolic equivalents<sup>14,19,20</sup> as the minimal threshold for moderate activity<sup>14,21</sup>.

Participants wore the accelerometers on an elastic belt on the right hip (anterior to the iliac crest). Children wore monitors during the 2-week monitoring period (weekdays and weekend days). Parents were instructed to remove the accelerometer only during water activities (bathing or swimming) and when the child went to bed at night. For inclusion in the current study, children were required to have at least 10 hours per day of wear time and at least 1 complete day's worth of activity.

### Interpretation of the NASPE Guidelines

The NASPE guidelines for preschool-aged children (aged 3–5 years) was interpreted as the following: 120 minutes of total daily physical activity (ie, light to vigorous); 120 minutes of daily MVPA; and 60 minutes of daily MVPA. The 120 minutes of total daily physical activity interpretation is consistent with previous studies that have used this operational definition.<sup>7,8</sup> This interpretation is based on the fact the NASPE guidelines fail to explicitly indicate the intensity of the physical activity; hence, total time spent in light, moderate, and vigorous physical activity were included in the calculation. The interpretation of the NASPE guide-

line as 60 minutes of MVPA is consistent with recent interpretations,<sup>5,22</sup> where, extrapolating from physical activity guidelines for school-aged children, 60 minutes of MVPA per day is recommended.<sup>23</sup> The final interpretation of the guidelines as 120 minutes of MVPA is based on the lack of specification of activity intensity (as mentioned previously) and was operationalized to be consistent with the guidelines for school-aged children that focus solely on MVPA.<sup>23</sup>

### Statistical Analysis

Initially, descriptive means and SDs were calculated. Tests between weekday and weekend day total physical activity and MVPA across the cut points, controlling for child-level (multiple days of activity monitoring nested within preschoolers) and preschool-level (multiple preschoolers attending the same preschool) clustering, indicated no significant difference by segment of the week. Therefore, all subsequent analyses included all days of the week. Because the NASPE guidelines call for preschoolers to achieve the benchmark on a daily basis, we analyzed the data in 2 distinct ways. For the first set of analyses, all days of measured physical activity were used.<sup>24</sup> This was performed because, for instance, a preschooler could have been monitored for 4 days with observed MVPA of 62, 123, 67, and 98 minutes per day. This preschooler would

have 4 days meeting the 60 minutes MVPA guideline and 1 day meeting the 120 minutes MVPA guideline. Hence, this prevalence rate represents the number of total days of valid accelerometer observation across the entire sample that preschoolers met the NASPE guidelines (according to the example, this would be a 100% adherence rate for 60 minutes of MVPA and a 25% adherence rate for 120 minutes of MVPA). In addition, using the child as the unit of analysis, we computed a prevalence rate on the basis of the number of days that met the NASPE guidelines for each child individually and divided this by the total number of days the child had valid accelerometer data.<sup>7</sup> In reference to the above example, the preschooler would have met the NASPE guideline interpretation of 60 minutes of MVPA daily and not met the guideline for 120 minutes of MVPA daily. Prevalence rates were computed for boys and girl, separately. Accelerometer estimates of physical activity intensity also were visually examined using distributional plots to illustrate the differences among prevalence rates across the 4 sets of accelerometer cut points. All analyses were performed using Stata (version 11; Stata-Corp, College Station, TX).

### RESULTS

The descriptive statistics of the sample, along with the estimates of total physical activity and MVPA, are presented in Table 2. The distributions of total physical activity and MVPA and the corresponding prevalence rates of meeting the NSAPE guidelines for 120 minutes of total daily physical activity, 120 minutes of MVPA, and 60 minutes of MVPA are presented in Table 3 and Figs 1 and 2. The proportion of valid accelerometer monitoring days that met the NASPE guidelines for 120 minutes of total physical activity, 120 minutes of MVPA, and 60 minutes of MVPA ranged from 45.7% to 99.9%, 0.4% to

**TABLE 2** Demographic Characteristics and Physical Activity Estimates of Preschool Children, *n* = 397

Variable	Mean	SD
Gender, boys, %	47.7	
Age, y	4.2	0.6
Height, cm	104.5	6.3
Weight, kg	18.1	3.9
BMI percentile	63.4	28.3
Accelerometer estimates of		
MVPA, min/d		
Pate et al <sup>15</sup>	102.2	40.6
Reilly and Puyau et al <sup>16,17</sup>	39.5	22.5
Sirard et al <sup>18</sup>	46.8	27.6
Freedson et al <sup>14,21</sup>	269.0	70.8
Accelerometer estimates of		
total physical activity, min/d		
Pate et al <sup>15</sup>	371.2	81.1
Reilly and Puyau et al <sup>16,17</sup>	153.7	51.3
Sirard et al <sup>18</sup>	127.3	47.5
Freedson et al <sup>14,21</sup>	402.5	83.6

99.2%, and 9.0% to 99.9%, respectively. The percentage of preschoolers that met the NASPE guidelines each day monitored ranged from 13.5% to 99.5%, 0.0% to 95.7%, and 0.5% to 99.5% for 120 minutes of total physical activity, 120 minutes of MVPA, and 60 minutes of MVPA, respectively.

## DISCUSSION

These findings clearly indicate that the interpretation of the NASPE guidelines and the accelerometer cut points used

to quantify levels of physical activity intensity has a strong impact on the prevalence of preschoolers accumulating sufficient amounts of health-enhancing physical activity. This has major implications in terms of establishing scientific evidence on the rates of physical (in)activity among preschoolers. Moreover, such inconsistencies create a situation whereby policy makers, public health officials, researchers, and the general public have limited knowledge on the extent to which preschoolers are physically active and what benchmarks in terms of accumulating sufficient levels of physical activity daily preschoolers should achieve.

Only two studies<sup>7,8</sup> have reported that the accelerometer assessed physical activity of preschoolers meeting NASPE guidelines. Cardon and De Bourdeaudhuij,<sup>7</sup> using the Sirard et al<sup>18</sup> cut points, reported that 7% and 26% of Belgium preschoolers met the 60 minutes of daily MVPA and 120 minutes of total daily physical activity, respectively. We found that 2.4 of 6.4% and 13.5 of 17.5% of girls and boys met these guidelines when interpreting the data using Sirard et al<sup>18</sup> cut points (see Table 2). Vale and colleagues,<sup>8</sup> using

the Pate et al<sup>15</sup> cut points, reported that 74.3% of Portuguese preschoolers met the 120 minutes of total physical activity on weekdays (59.2% on weekends), whereas 93.5% met the 60 minutes of MVPA on weekdays (77.6% on weekends). We found no difference between weekdays versus weekend days. However, our estimates with the Pate et al<sup>15</sup> cut points indicated that almost all preschoolers met the 120 minutes of total physical activity (99.5%), with a large proportion of boys (65.6%) and girls (52.9%) meeting the 60 minutes of MVPA. Two other studies<sup>5,6</sup> found that anywhere from 54% to 80% of preschoolers meet NASPE guidelines. As mentioned previously, these studies interpreted the NASPE guideline as 3 or more hours of physical activity daily<sup>6</sup> or included measures of physical activity of low accuracy (eg, parent proxy reports).<sup>5,6</sup>

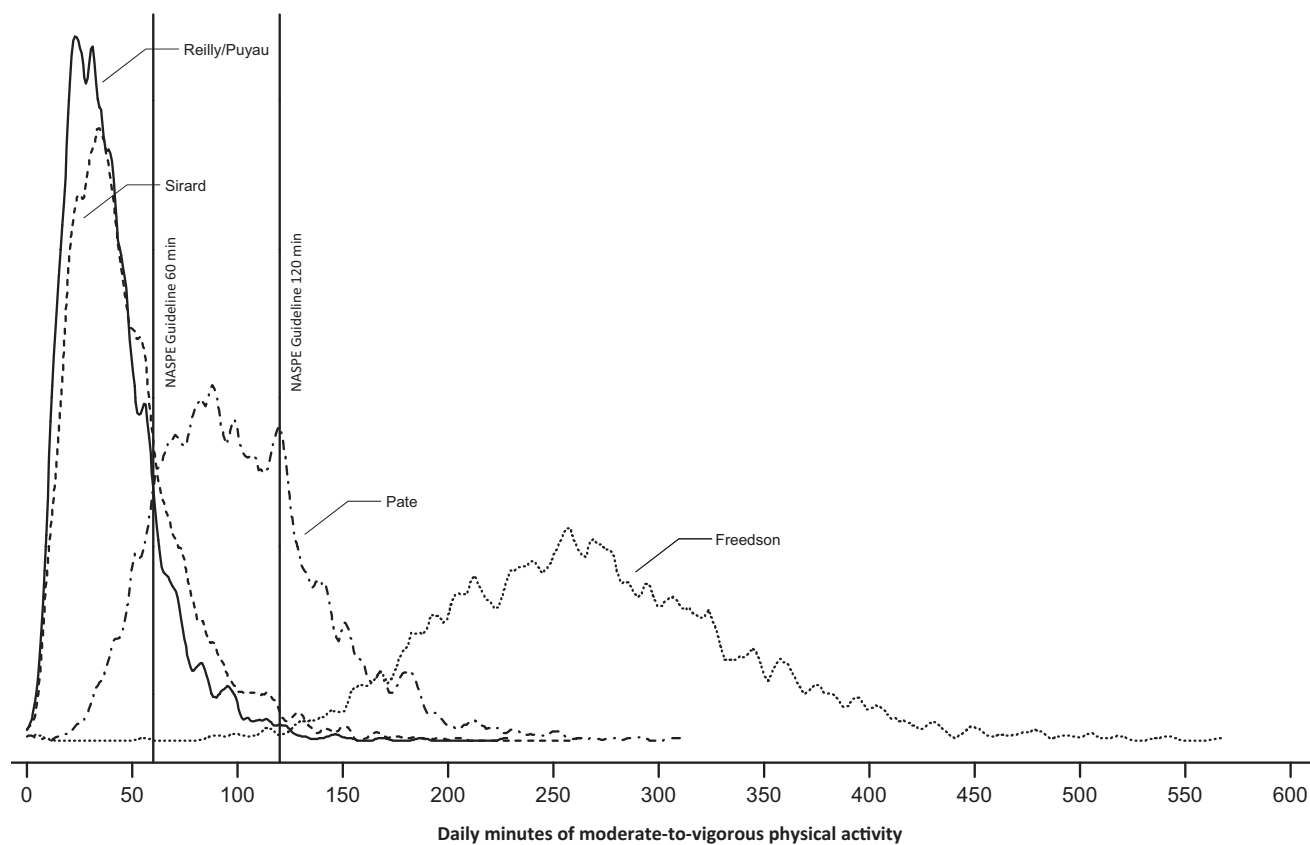
Potential solutions to the issue of guideline interpretation and selection of appropriate accelerometer cut points for preschoolers require careful consideration. When developing physical activity guidelines, attention needs to center on the ability to operationalize the guidelines across multiple audiences. Practitioners require easily interpretable guidelines that can inform routine practice in regards to their contribution to preschoolers overall physical activity. For the research and public health community, the ability to translate a guideline into measurable units necessitates that a guideline be void of ambiguity. In the current form, the NASPE guidelines do not clearly specify activity intensity or the amount of time preschoolers should accumulate at a given intensity. Simply, it states 120 minutes of physical activity, which has been interpreted in multiple ways.<sup>5,6,8,22</sup> Moreover, a guideline should be based on aspects of physical activity behavior that are measurable. The NASPE

**TABLE 3** Prevalence (%) of Compliance to 3 Interpretations of the NASPE Guidelines According to 4 Sets of Accelerometer Cut Points

Unit of Analysis	NASPE Guidelines Interpretation					
	120 Minutes Total Physical Activity		120 Minutes MVPA		60 Minutes MVPA	
	Boys	Girls	Boys	Girls	Boys	Girls
Observations <sup>a</sup>						
Cut Points						
Reilly and Puyau et al <sup>16,17</sup>	77.8	70.5	1.1	0.4	21.6	9.0
Sirard et al <sup>18</sup>	58.8	45.7	3.4	0.8	31.3	18.1
Pate et al <sup>15</sup>	99.9	99.9	37.3	22.1	89.9	86.6
Freedson et al <sup>14,21</sup>	99.9	99.9	99.2	99.2	99.9	99.9
Child <sup>b</sup>						
Cut Points						
Reilly and Puyau et al <sup>16,17</sup>	39.7	27.4	0.0	0.0	3.7	0.5
Sirard et al <sup>18</sup>	17.5	13.5	0.5	0.0	6.9	2.4
Pate et al <sup>15</sup>	99.5	99.5	7.9	3.4	65.6	52.9
Freedson et al <sup>14,21</sup>	99.5	99.5	95.2	95.7	99.5	99.5

<sup>a</sup> Boys, *n* = 1120 days of valid accelerometer data; girls, *n* = 1229 days of valid accelerometer data.

<sup>b</sup> Boys, *n* = 189; girls, *n* = 208.



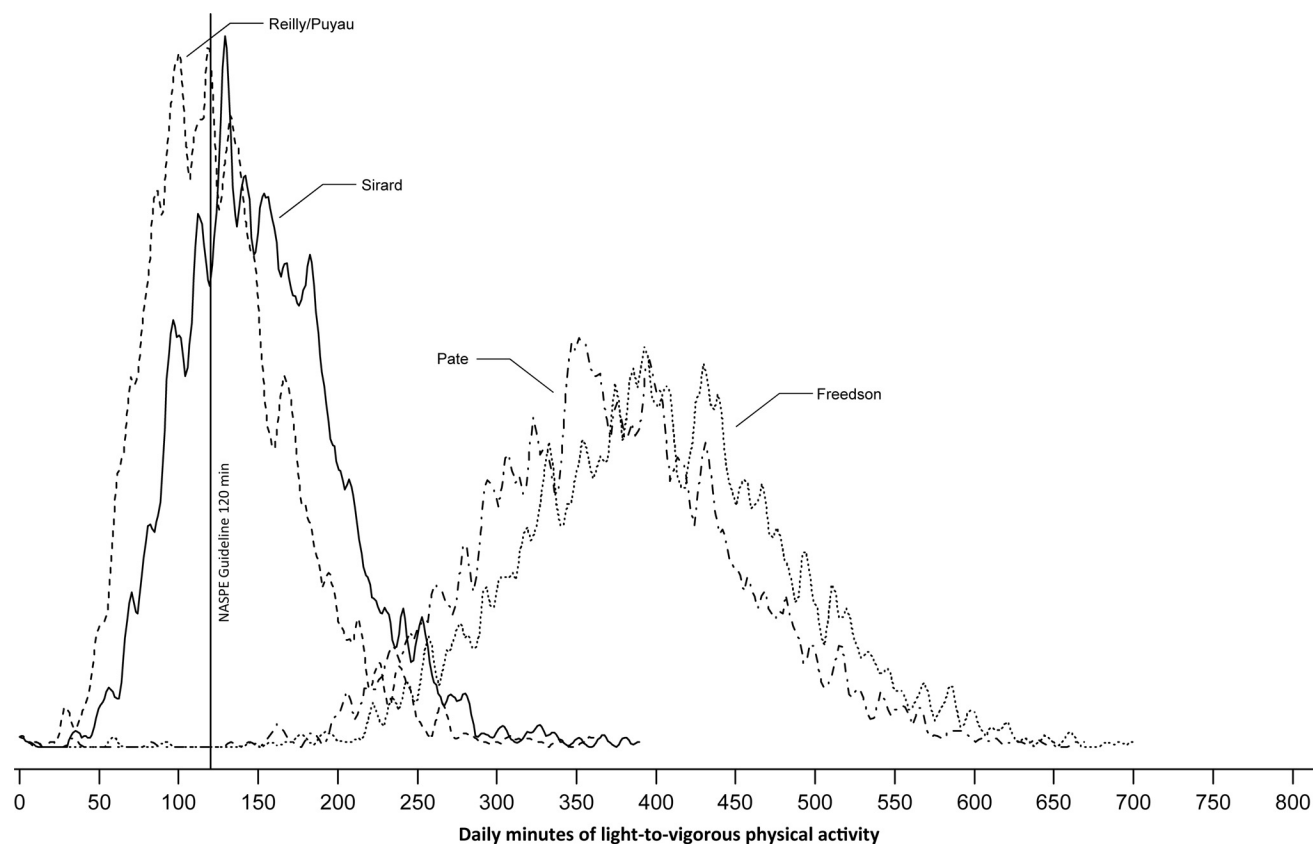
**FIGURE 1** Distribution of observations ( $N = 2349$ ) meeting two interpretations of the NASPE physical activity guidelines for MVPA.

guideline currently states that preschoolers should accumulate 60 minutes of both structured and unstructured physical activity. At present, there are no clear definitions of what constitutes either structured or unstructured, and even with clear definitions, the feasibility to quantify such information would be limited.

The issue regarding appropriate accelerometer cut points potentially is a greater hurdle to surmount. Existing cut points for preschoolers have been developed using different criterion measures (ie, indirect calorimetry<sup>15</sup> and systematic observation<sup>18</sup>), were developed on older samples (ie, 6–16 years<sup>16</sup> and 6–18 years<sup>14,21</sup>), used different physical activities to simulate light-to-vigorous intensities (ie, slow-to-fast walking<sup>14,15,18,21</sup> or a variety of free-living activities<sup>16</sup>), or were developed on a small number of preschool-

ers (ie,  $n = 29$ ,<sup>15</sup>  $n = 16$ ).<sup>18</sup> The variability in the protocols and samples are likely culprits in the sizeable differences in estimates of physical activity observed across the cut points. Future research should focus on establishing the validity of the existing cut points through independent validation studies.<sup>25,26</sup> In the event that none of the cut points provide comparable accuracy, additional calibration studies using recommended methodology<sup>14</sup> will need to be conducted. Unfortunately, without this research, along with national and perhaps international consensus, the application of different cut points is likely to continue. Until then, the interpretation of preschoolers meeting physical activity recommendations needs to be conducted with caution, given the vastly different estimates of physical activity associated with a given set of cut points.

An additional caveat in determining compliance is the issue with meeting the guideline on a daily basis. This implies that a preschooler accumulates the requisite amount of physical activity each day. As the following example illustrates, a child that accumulates 60, 138, 102, or 180 minutes of MVPA would be classified as meeting the guideline of 60 minutes of MVPA daily, whereas they would have failed to meet the 120 minutes of MVPA daily guideline. Studies that average the number of minutes of physical activity over 2 or more days may artificially suggest a child meets the guideline.<sup>8</sup> For instance, using the example, the average MVPA of this child is 120 minutes. Hence, both the 60 and 120 minutes of MVPA guideline would have been met. Clearly, this can introduce substantial variability when attempting to estimate compliance rates. Be-



**FIGURE 2**  
Distribution of observations ( $N = 2349$ ) meeting the NASPE 120 minutes of daily total physical activity (light-to-vigorous).

cause the guideline does specify “daily physical activity,” we recommended that each day be examined for compliance and not the average minutes of physical activity across days. We recognize that this may penalize preschoolers that miss a day because of factors outside their control (eg, inclement weather). Such scenarios need to be considered in the phrasing of new guidelines, with possible wording that calls for “5 of 7 days” or “most days of the week.” Care, however, should be taken to ensure that the number of days preschoolers should achieve the recommended physical activity levels also is void of ambiguity. Nevertheless, the “every day” recommendation is consistent with national guidelines for youth aged 6–18 years<sup>25</sup> and physical activity recommendations for preschoolers in Australia.<sup>27</sup> Furthermore, care needs to be taken in any interpretation of the NASPE guidelines as

120 minutes of MVPA. The use of the 120 minutes of MVPA as an interpretation was based on the lack of specificity in the original guidelines and represents 1 of many possible interpretations. The authors, however, do not advocate the interpretation of the NASPE guidelines as such but rather have used the 120 minutes of MVPA to illustrate the various ways in which it could be interpreted.

The recent release of the first National Physical Activity Plan for the United States (found at [http://physicalactivityplan.org/education\\_st2.php](http://physicalactivityplan.org/education_st2.php)) brings particular urgency to these issues. Strategy number 2 in the education sector of the National Physical Activity Plan recommends that “state and school district policies requiring school accountability for the quality and quantity of physical education and physical activity programs” be developed and implemented.

One way to mark progress, or lack thereof, for this strategy will be to solve the issues presented here.

## CONCLUSIONS

Concerted efforts need to be made in clarifying the NASPE guidelines by explicitly indicating what constitutes sufficient levels of health-enhancing physical activity. Concurrently, the scientific community needs to resolve the issue of which accelerometer cut points are the most appropriate. Not until both of these issues are solved can a clear picture be made on the extent to which preschoolers engage in regular physical activity.

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