

## **Abstract**

**BACKGROUND:** After-school programs (ASP) provide opportunities to influence children's physical activity (PA). However, little is known about the PA levels of the youngest schoolchildren. The aim of the study was to describe the level of physical activity intensity and sedentary time among first graders attending ASP in Norway, and to investigate factors that are associated with PA in the ASP.

**METHODS:** First graders from 14 ASPs were invited to participate in the study and 426 children were included. The children wore an accelerometer for five consecutive days during their stay in the ASP. Light, moderate and vigorous physical activity and sedentary time were registered and analyzed.

**RESULTS:** On average, the children accumulated 25.8 minutes of moderate and vigorous physical activity (MVPA) during their ASP-stay. However, there was considerable variation within the sample. Sex, as well as body mass, were associated with MVPA. The activity level increased substantially when the children had to be outside.

**CONCLUSIONS:** The findings show that on average, the children were quite physically active in the ASP. However, it seems critical to devote increased attention to the least active children and to include extensive outdoor play-time in the ASP schedule.

Key words: After-school program, children, physical activity, play, outdoor play, school health

A great number of studies have shown benefits of regular physical activity (PA) on health and well-being in school-aged children.<sup>1, 2</sup> Recent studies also emphasize the role played by children's physical-motor functioning and activity levels in functioning and academic performance in school, and as a preventive mechanism against antisocial behavior.<sup>3,</sup>  
<sup>4</sup> However, the increasing levels of sedentary time are an issue of concern.<sup>5</sup> Lack of PA is associated with childhood obesity and poses a threat to children's overall physical and psychosocial functioning.<sup>6</sup>

Evidence-based recommendations establish that children should be physically active, at moderate or vigorous intensity levels (MVPA), at least 60 minutes per day.<sup>7</sup> The proportion of children who meet the recommendations is high for the youngest schoolchildren, but PA levels decrease significantly with increasing age.<sup>8</sup> Moreover, the numbers represent average levels and the variation is considerable. There seems to be a small group that is very sedentary.<sup>8</sup> It has been suggested that there is a reciprocal and developmentally dynamic relationship between motor skill competence and physical activity, a relationship that becomes strengthened during the course of childhood.<sup>9</sup> In early childhood, increased PA provides more opportunities for motor development, while motor skill competence drives PA.<sup>9</sup> Children with less-proficient levels of motor skill competence will engage in lower levels of PA. This can lead to a vicious circle ending in sedentary behavior and low level PA later in life.<sup>5</sup>

Organizational efforts in kindergarten and school may have an effect on PA levels among the children.<sup>10</sup> Whether or not the institutions are likely to promote PA, is dependent on the social and physical environment.<sup>11</sup> As much as 97.5% of Norwegian five-year-olds attend kindergarten, making the kindergartens important arenas for laying the foundation for future health.<sup>12, 13</sup> Research on children aged 4 -5 years show higher PA levels during outdoor play time compared to time spent indoors.<sup>14, 15</sup> Outdoor play is strongly emphasized in

Norwegian kindergartens. A study found that children are outdoors more than four hours in summertime and between one and two hours in the winter.<sup>16</sup> However, in the school, PA is often limited to physical education classes or short recesses. As a result, the school struggles to provide enough opportunities for the children to meet the PA recommendations.<sup>17</sup> Extra-curricular PA in after-school programs (ASP) might provide opportunities for children to be physically active within the school environment.<sup>18</sup> According to the Education Act, Norwegian ASPs are obligated to provide care and supervision and offer the children opportunities for play, cultural and leisure activities.<sup>19</sup> Thus, ASP is an institution based on a pedagogical perspective closely related to the kindergarten's perspective. As many as 81% of the first graders (six years old) attend ASP between 10 and 20 hours each week.<sup>20</sup> Hence, the ASP-context provides opportunities to influence physical activity levels in young schoolchildren.

There is limited research on children's accumulation of PA in Scandinavian ASPs. American studies have reported PA levels in ASPs from data collected with accelerometers.<sup>21</sup> <sup>22</sup> In general samples, the average amount of MVPA in ASP falls well below 30 minutes, which is the pronounced goal in evidence-based recommendations for MVPA in American ASPs.<sup>21</sup> Typical findings are that boys exhibit more MVPA and less sedentary activity compared to girls, and that older children exhibit less MVPA than younger. Previous studies focusing on PA in children with overweight or obesity, suggest that in an ASP context, overweight children do not engage in less MVPA than their normal weight peers.<sup>22</sup> Qualitative studies and small-scale quantitative studies in Norway report that physical activity during ASP is extensive when children have time devoted to child-managed play outdoors and that children play because it is fun. Nevertheless, a significant minority of children fall by the wayside, and this seems to hamper their activity level.<sup>23, 24</sup>

In contrast with the sports-dominated extra-curricular physical activity in other countries<sup>25</sup>, Norwegian ASPs are expected to encourage self-managed activities.<sup>19</sup> The ASPs are generally located at the school area and use the school's facilities and playground. The playgrounds commonly offer a combination of open spaces, climbing frames, swings and sandpits, places for ball games and places with natural elements. Typical equipment available is balls, hula-hoops, jumping ropes, tricycles and scooters, and sandpit equipment.<sup>26</sup> Hence, a study of physical activity in this context will be of interest. In current literature, there is a lack {Lund, 2017 #357}of research focusing explicitly on the youngest ASP-children. Moreover, it is important to discover groups of children with a high proportion of sedentary behaviors and low activity levels in early childhood.<sup>5</sup> Knowledge about individual and organizational factors that are associated with PA, will be of particular interest in order to facilitate future interventions tailored to increase and support MVPA among all children.

The aim of this study is to describe the level of PA intensity and sedentary time among first graders attending after-school programs in Norway and to investigate factors that are associated with PA in the ASP.

## **METHODS**

### **Participants and Data Collection**

The data included in this article were collected in October 2016 at baseline of a cluster randomized controlled trial assessing the effect of an intervention to support young children's physical activity play in ASP (ClinicalTrials; NCT02954614). The protocol is previously described.<sup>27</sup> Municipalities in three counties in eastern parts of Norway were requested to participate. School physiotherapists assisted in recruitment of ASPs within their area of responsibility. School administrators gave their consent before parents of all first graders attending ASP were informed about the study, and asked for a signed consent on behalf of

their children. There were no exclusion criteria. In the present article, data from the intervention- and the control ASPs are analyzed as one sample.

## **Instrumentation**

Information on gender was collected at study start. Child height and weight were measured using a stadiometer and a digital scale at the school nurses' offices. The children wore light clothes and no shoes. Body mass index (BMI= kg/m<sup>2</sup>) was calculated and converted to age and gender specific scores.<sup>28</sup> For the analyses, children with overweight and obesity (BMI  $\geq$  25) were collapsed into one category.

Objective assessments of PA were obtained using the ActiGraph GT3X accelerometer (Actigraph<sup>TM</sup> LLC, Pensacola, US) during ASP-time over a period of one week (Monday to Friday) in October 2016. The children wore the monitors for their entire attendance at the ASPs throughout the week of assessment. Valid files of accelerometer data consisted of at least two days of at least 60 minutes accelerometer wear time. Non-wear time was defined as 20 minutes of consecutive zeroes, allowing for 2 minutes above zero. All data registered before or after opening and closing hours for each school were labelled as non-wear time and excluded from analysis. Using ActiLife version 6.13.3, raw accelerometer files were downloaded and then reintegrated in 10-s epochs to detect the intermittent activity patterns of children. The files were then loaded into Kinesoft v3.3.80 (Kinesoft, SK) for screening and analysis. The number of minutes spent in MVPA was estimated with cut points as described and recommended in previous studies.<sup>29, 30</sup> Moderate and vigorous physical activity was defined as above 2295 counts per minute (CPM), light activity between 101 and 2294 CPM, and inactivity as less than 101 CPM.<sup>29</sup> A sedentary bout was defined as a period of 10 consecutive minutes or more with counts less than 101, allowing for two exceptions.

Publications including accelerometers vary widely in their definition of intensity thresholds,

which makes it difficult to compare the results. Thus, we report on CPM as well as minutes of sedentary time and MVPA.

For the entire week of PA assessments, the staff recorded relevant information in a log scheme: the weather conditions, opening and closing hours, mandatory time spent outdoors, time and duration of optional organized and unorganized activities outdoors and indoors.

### **Data Analysis**

Due to the small number of missing values, no imputation of values was considered necessary. Distributions of the continuous variables were inspected visually. Normally distributed data are described with mean and standard deviation (SD), otherwise with median and range. Possible differences between pairs of continuous data were assessed using independent samples t-tests and paired samples t-tests. P-values of  $<.05$  were considered statistically significant. The results are presented as point estimates of mean differences between groups with 95% CI. All analyses were performed using SPSS©24.0.

### **RESULTS**

In total, 14 ASPs agreed to participate. Parents of 456 children allowed their children to be included in the study, while parents of 203 children rejected participation or forgot to provide written consent. Three of the accelerometers failed to record activity. Twenty-seven children did not meet the requirement of valid days. Consequently, 426 participants were included in the analyses, of which 47.8% were girls and 16.9% had an age- and gender adjusted BMI indicating overweight or obesity.

A great majority (70.8 %) of the participants attended the ASP four or five days the week of measurements. The mean time spent in the ASP per day was 164.5 minutes. On

average, the children spent 52.6 minutes outdoors (mandatory) per day. However, most of the time, the children could choose if they wanted to play or join activities indoors or outdoors. The logs indicated that most of the time spent outdoors was devoted to child managed activities with friends and that the children could choose where to play and what equipment to use. The ASPs in this study were representative for Norwegian ASPs with respect to design and equipment. The ASPs typically offered one meal per day of approximately 30 minutes.

The schools varied in size and location. Our data did not reveal any cluster effect when controlling for school size (small versus large) or geography (urban versus rural). The weather was mainly cloudy and dry, and mean temperatures did not differ greatly between the ASPs during the weeks of assessment (4-9°C). Thus, weather conditions were not controlled for in the analyses.

[Insert table 1 here]

The children's mean (SD) CPM during the total stay in the ASP was 1042.1 (333.2). Applying cut points as described showed that the children had 66.7 min of sedentary activity on average per day in the ASP (table 1), with a variation from 18.4 min to 138.6 min. Average time spent in MVPA was 25.8 min, ranging from 0.5 min to 73.4 min. Sedentary time made up for 40% of total ASP-time, while MVPA made up for 16 %, while 72 min (44%), was spent in light intensity activities.. Total sedentary time was moderately negatively correlated with MVPA ( $r= 0.30$ ,  $p < .01$ ), meaning that sedentary children also achieved less physical activity of moderate and vigorous intensity. On average, the girls spent significantly more minutes in sedentary activities per day compared to the boys (mean difference 14.4 min, 95%CI=10.6 to 18.1],  $p < .01$ ), while the boys spent more minutes in MVPA per day (mean difference 8.2 min, 95%CI=6.3 to 9.8,  $p < .01$ ). During the entire week of measurement, median sedentary bouts were 6 for the girls and 4 for the boys. For both girls and boys, there

was a considerable variation of sedentary bouts from 0 to 19 and 18 respectively. Children with BMI  $\geq 25$  had less minutes of MVPA per day compared to children with BMI  $< 25$  (mean difference 3.2 min, 95%CI=0.3 to 6.1,  $p < .05$ ).

During mandatory outdoor time, the mean (SD) CPM was 1581.3 (588.9). On average, the children were engaged in sedentary activities for 13.6 minutes (26% of total mandatory outdoor time), in MVPA for 13.1 minutes (25%), while 26 minutes (49%) were spent in light intensity activities. The girls spent significantly more minutes in sedentary activities outdoors per day compared to the boys (mean difference 4.5 min, 95%CI=2.7 to 6.2,  $p < .01$ ), while the boys had more minutes in MVPA (mean difference 2.8 min, 95%CI=1.4 to 4.2,  $p < .01$ ). Comparing mandatory time outdoors with remaining ASP-time (time including meals and optional activities indoors and outdoors) showed that both girls and boys were significantly more active when they had to be outdoors. Among the girls, MVPA accounted for 22.2% of the mandatory time spent outdoors, compared to only 8.6 % of remaining time (mean difference 13.6%, 95%CI=12.4 to 14.8,  $p < .01$ ). As for the boys, 28% of mandatory time outdoors and 13% of remaining time were spent in MVPA (mean difference 15%, 95%CI=13.6 to 16.2,  $p < .01$ ). There were no differences in mandatory outdoor activity levels between children with BMI  $\geq 25$  and children with BMI  $< 25$ .

When dividing the sample in quartiles based on mean daily CPM, we found that children in the most active quartile (Q4) were twice as active as those in the least active quartile (Q1); 1488.3 CPM compared to 673.6 CPM (table 2), with a mean difference of 814.7 CPM (95%CI=759.2 to 870.3),  $p < .01$ . On average, children in the most active quartile spent 35.9% of their time in MVPA when being outdoors compared to 16.6 % among the least active quartile (mean difference 19.3%, 95%CI=17.3 to 21.5,  $p < .01$ ). During remaining time, 16.8 % and 6.4% was spent in MVPA for the most and the least active quartile respectively (mean difference 10.4%, 95%CI=9.1 to 11.7,  $p < .01$ ) (figure 1).



[Insert figure 1 here]

Median sedentary bouts during the five days of measurement were 3 for the most active quartile, while median sedentary bouts for the least active quartile were 7.5. In the most active quartile, 72% were boys while 71% in the least active quartile were girls. 11% of the children in the most active quartile, and 27 % in the least active quartile, had an age- and gender adjusted  $BMI \geq 25$ . There were only minor differences between the quartiles with regards to minutes spent in the ASP during the week of measurement.

[Insert table 2 here]

## **DISCUSSION**

There are increasingly less opportunities for play and PA during school hours, giving the ASPs an important role in activity promotion.<sup>22</sup> However, little is known about PA in young schoolchildren in ASPs. The present study is the first large-scale study to investigate PA levels in Norwegian ASPs. During the week of measurement, the children accumulated an average of 25.8 min of MVPA per day. This means that while being in the ASP, the children achieved almost half of the recommended 60 daily minutes of MVPA. We acknowledge that ASP contains more than physical activities. The Norwegian Education Act establishes that ASP should provide various cultural and leisure-time activities.<sup>19</sup> Thus, there is a threshold for how much MVPA a child can produce within 2-3 hours. However, there is reason to be concerned about the immense variation in MVPA, and particularly the fact that some of the children accumulated almost no MVPA at all. Although, in general, the children had few sedentary bouts during the five days of measurement, the least active quartile had more such

sedentary periods than the most active. Among some of the children in the least active quartile, we registered as much as 19 bouts, meaning that they had almost four 10-mins bouts of complete inactivity per day in the ASP on average. The least active quartile of children produced less MVPA throughout the entire time spent in the ASP. Our data cannot explain the causes for the variation in activity levels. However, some associations seem important. The findings showed that the girls were significantly less active than the boys. The girls spent more time in sedentary activities and less time in MVPA. Although an 8.2 minutes difference in MVPA between genders may seem unimportant, this accumulates to notable amounts over a week, not to mention during a year. Moreover, our findings correspond with results from studies, including all-day measurements, showing that girls are generally less physically active.<sup>31,32</sup> Norwegian ASPs are relatively autonomous with respect to how they operate. This entails a great responsibility, but also great possibilities to even out gender differences and ensure sufficient PA for all children.

The results of the present study showed a statistically significant difference in MVPA between children with BMI<25 compared to children with overweight or obesity. Again, it can be argued that the difference in minutes spent in MVPA per day is of modest clinical importance. However, we claim that our findings are of value as they support previous studies of older children and adolescents, showing that BMI is associated with physical activity.<sup>33</sup> The fact that this is observable as early as among six year olds, gives rise for concern. The mechanisms underlying the relationship between body mass and PA are not fully explored, but it is found that body composition is associated with motor skill competence and health-related fitness.<sup>34</sup> Controlling a larger body mass impedes functional movement, particularly in locomotor and stability skills, which may lead to less MVPA as the children choose more sedentary activities.

Research indicates that cardiorespiratory fitness benefits will occur in most children who participate in 60 or more minutes of daily MVPA.<sup>1, 35</sup> Correlation is found between motor competence and physical fitness in children aged 4-6 years.<sup>36</sup> However, the concept of 'physical fitness' refers not only to cardiorespiratory fitness, but also to characteristics that affect the ability to perform physical activity, like strength, motor coordination, balance, and agility.<sup>37</sup> Physical activity below the moderate intensity level can contribute positively to these fitness components and, in turn, help to improve motor skill competence. Thus, it is highly relevant to investigate what types of movement light intensity physical activities imply, and if these activities can stimulate motor competence. As part of the present study, we have observed a sample of the children during ASP-time. The results will be published in an upcoming article.

Gross motor competence is ideally learnt during preschool and early school years.<sup>38</sup> Thus, it is decisive that institutions, in which young children spend much of their waking hours, ensure sufficient opportunities for physical activity play. The design of the outdoor area and equipment available is of great importance for the children's activity level and development and learning of motor skills.<sup>39, 40</sup> The current study shows how organizational efforts associate with levels of PA intensity. During mandatory time outdoors, the activity level increased significantly among all children. When the children had to be outside, CPM was twice as high as during the remaining time spent in ASP. Some of the difference may be explained by the meals, which were included in remaining time. Eating a meal obviously leads to decreased activity counts, as the children are encouraged to sit still while they eat. However, meals cannot explain the entire difference. When given the opportunity, it seems as if many children chose to go inside with the immediate consequence of a decreased PA intensity level.

## **Limitations**

There are some limitations to the study. Due to organizational variation and lack of firm structure, between the ASPs and from day to day within the ASPs, it was challenging to isolate and categorize time spent in different activities in a meaningful way. It was also impossible to subtract meals, as some ASPs organized the meals for groups of children at different hours. Thus, from the logs provided by the ASP staff, only mandatory time outdoors was obtained. This led to a loss of information about intensity levels during organized and unorganized activities in the remaining time. Moreover, lack of additional data on the children and their parents limited our possibility of a more thorough investigation of the characteristics of the children. Generalizability of the study was reduced because of the lack of information about potential participants who declined participation.

## **Conclusion**

The present study adds to the limited research on children's PA in ASPs. The results show that although, on average, children accumulated almost 50 percent of the recommended 60 minutes of daily MVPA during ASP-time, the variation between children is considerable. Children in the most active quartile were twice as active as those in the least active quartile. Gender, as well as body mass, were associated with MVPA. The children were a lot more active during mandatory outdoor time than during the remaining time spent in the ASP. The findings show that on average, the children were quite physically active in the ASP. However, possibilities for improvement may be realized by devoting increased attention to the least active children, and by utilizing and treasuring the potential for increased PA that lies in outdoor playtime.

## IMPLICATIONS FOR SCHOOL HEALTH

As mentioned in the introduction of this article, research literature has shown benefits of regular PA on health and well-being in school-aged children. A great proportion of young children attend the ASP where they spend several hours per week. Thus, measures that can increase PA in the ASP have the potential to reach a large group of children. The present study shows a considerable difference of daily MVPA between the most active and the least active quartile of children. However, it seems as if outdoor playtime is an appropriate way to increase MVPA among all children, including the least active children. Based on these results, we recommend that ASP-staff develop and implement strategies to ensure daily mandatory out-door play and activities. Such strategies could for instance include:

- give access to stimulating outdoor play areas
- introduce ideas for activities for different weather conditions
- arrange weekly hikes in the neighborhood
- facilitate outdoor meals
- give information to parents on suitable outdoor clothing for the child

Most importantly, ASP-staff should ensure that time is devoted to child-managed play, and involve the children, in particular the least active children, in the planning of outdoor activities.

Consistent with previous studies we also found broad variation between children in time spent in sedentary activities. Some children were remarkably inactive. ASPs should be concerned with identification of these children and give them sufficient support to increase their PA. However, in Norway, as in many other countries, only a minority of the employees in ASPs have formal pedagogical education. There seems to be a lack of competence in how to approach and engage in children's physical activity play.<sup>41</sup> Thus, there is a need for knowledge on how child-managed play can contribute to increased physical activity, and how

ASP employees can promote such play. On this basis, we recommend tailored courses for ASP staff. Additionally we recommend closer cooperation between the ASP and professionals with particular competence on planning, facilitating and promoting physical activity play, and on assessing motor skills and difficulties in children. Trained physical education teachers and physiotherapists are skilled professionals with such expertise, and should thus be a more integrated part of ASP. We believe this could support and increase PA, especially among the least active children, and thus contribute positively to their health. However, intervention studies will be needed to evaluate such measures.

### **Human Subjects Approval Statement**

Only children, for whom the parents had provided written consent, were included in the assessments. The study was first reviewed by The Regional Committee for Medical and Health Research Ethics. The Committee concluded that the study is not covered by the Health Research Act. Consequently, the study protocol was reviewed by The Data Protection Official for Research (NSD) to ensure that the project is in accordance with the Personal Data Act and the Personal Health Data Filing System Act (reference number 46008).

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**Table 1 Accelerometer Data for the Total Sample and Subgroups Given in Mean Minutes per Day and CPM.**

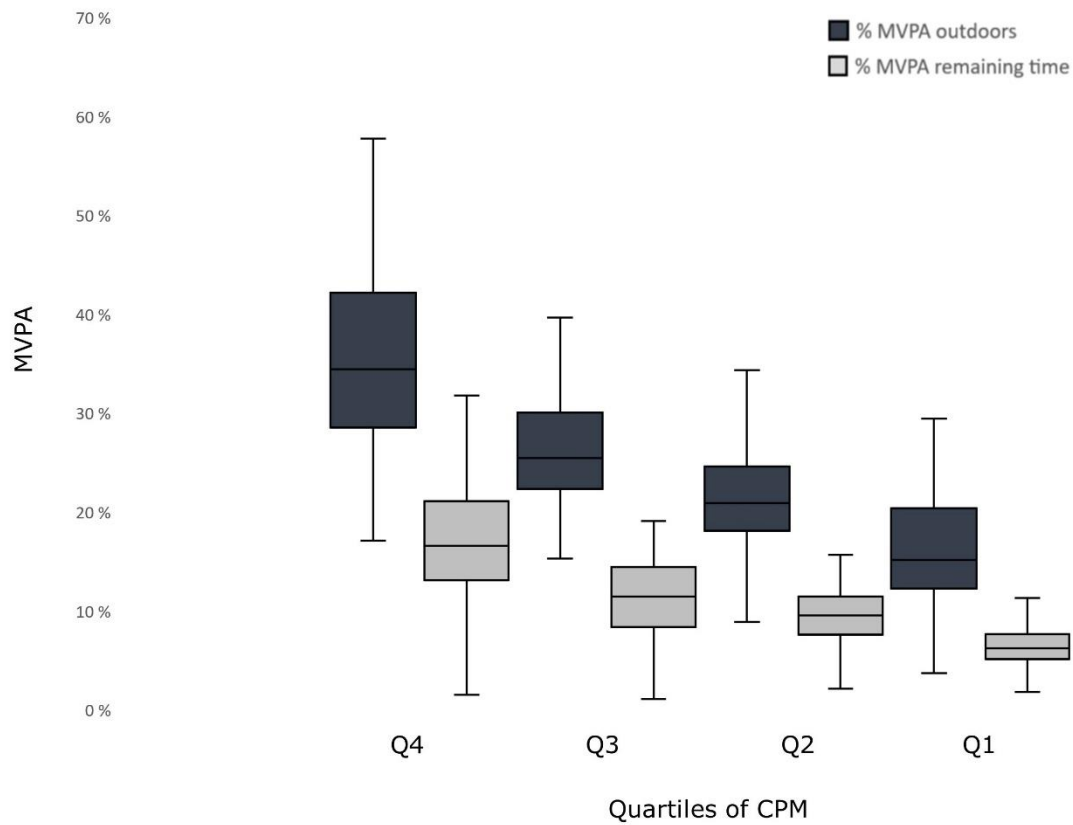
		All (N=426)		Girls (N=202)		Boys (N=224)		p*	BMI<25 (N=350)		BMI≥25 (N=68)		p*
		Mean	SD	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
TOTAL TIME	SA	66.7	20.5	74.3	21.0	59.9	17.4	<.01	66.2	20.6	68.9	18.4	.32
	LPA	72.0	16.1	69.8	15.5	73.9	16.5	<.01	71.6	15.8	73.5	17.5	.38
	MVPA	25.8	10.6	21.5	7.5	29.7	11.5	<.01	26.3	10.2	23.1	11.1	<.05
	CPM	1042.1	333.2	935.9	298.8	1137.8	334.2	<.01	1060.7	329.6	951.4	335.4	<.05
OUTDOORS	SA	13.6	9.4	15.9	10.1	11.5	8.1	<.01	13.6	9.3	13.7	9.9	.90
	LPA	26.0	13.6	26.4	13.4	25.6	13.8	.55	25.9	13.6	26.8	14.4	.60
	MVPA	13.1	7.4	11.6	5.6	14.4	8.4	<.01	13.3	7.5	11.9	6.9	.14
	CPM	1581.3	588.9	1477.4	540.0	1676.7	616.4	<.01	1606.2	601.8	1464.3	522.6	.07
REMAINING TIME	SA	53.1	19.0	58.4	19.8	48.4	17.0	<.01	52.6	19.0	55.1	18.6	.31
	LPA	46.0	16.9	43.9	15.7	48.3	17.6	<.01	45.7	16.3	46.6	19.5	.67
	MVPA	12.8	8.3	9.9	5.5	15.3	9.5	<.01	13.0	8.0	11.2	8.7	.11
	CPM	779.1	312.7	668.2	249.1	879.0	330.6	<.01	792.9	305.2	704.4	329.2	<.05

\*P-values for the difference between subgroups.

**Table 2 Physical Activity for the 25% Most Active Children (Quartile 4) to the 25% Least Active Children (Quartile 1)\***

Quartile	CPM (SD)	% MVPA outdoors, mean (SD)	% MVPA remaining time, mean (SD)	% boys	% BMI $\geq$ 25	Sedentary bouts for all 5 days, median (min-max)
4	1488.3 (267.3)	35.9 (8.7)	16.8 (6.3)	72	11	3 (0-10)
3	1086.5 (60.2)	26.5 (8.2)	11.3 (3.9)	59	14	4 (0-13)
2	916.9 (52.1)	21.9 (6.5)	9.3 (3.2)	50	11	6 (0-17)
1	673.6 (113.9)	16.6 (6.8)	6.4 (2.4)	29	27	7.5 (0-19)

\*Based on Mean CPM.



**Figure 1 Percent of MVPA in Mandatory Outdoor Time and Remaining Time for the 25% Most Active Children (quartile 4) to the 25% Least Active Children (quartile 1). Based on Mean CPM.**