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ARTICLE



Physical activity and sedentary behaviour during outdoor learning and traditional indoor school days among Finnish primary school students

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ABSTRACT

In this study, we aimed at comparing Finnish primary school students' physical activity and sedentary time during outdoor-learning and traditional school days. Outdoor learning is defined as purposeful and planned learning experiences in the outdoors. The study population consisted 20 students in grades 1–6 at one primary school. Physical activity was measured objectively by hip-worn accelerometers. The amounts of physical activity and sedentary time were compared for the same students between five school days with outdoor learning and four traditional school days. The study's main findings show that, moving from traditional classroom teaching to an outdoor-learning environment decreases students' sedentary time and increases light- and moderate-intensity physical activity during the school day. No differences were observed in leisure-time physical activity on school days with or without outdoor learning. Thus, outdoor learning is an effective complement to traditional classroom teaching in promoting physically active children.

KEYWORDS

Outdoor learning; primary school students; physical activity; sedentary behaviour

Regular physical activity is essential for the health and well-being of children and young people (Physical Activity Guidelines Advisory Committee, 2008). Based on the global recommendations on physical activity for health, children and young people should engage in at least 60 min of moderate-to-vigorous-intensity physical activity (MVPA) every day (Organization, 2010). Single sessions of physical activity and physical activity interventions have also been shown to benefit children's cognitive functioning (Donnelly et al., 2016). Despite the well-known benefits of physical activity, the majority of school-aged children do not meet the minimum recommendations for daily physical activity (Ekelund, Tomkinson, & Armstrong, 2011). Based on objective measurements using accelerometers in Finland, 49% of primary school students achieve the recommended minimum of at least 1 h of MVPA per day, and on average, 22 min (one-third of children's daily MVPA) occurred during the school day (Tammelin, Kulmala, Hakonen, & Kallio, 2015). Children spend their days highly sedentary both during and outside school hours, although sedentary guidelines suggest that extended sitting time and time spent indoors throughout the day should be limited in children (Tremblay et al., 2011). Findings show that average total time spent sedentary per day is 6 h and 24 min among Finnish primary school students (Tammelin et al., 2015). This means that 47% of children's daily sedentary time occurs during the school day, on average 39 min per hour. The consequences of excessive sedentary time for children are not yet well understood, but growing

evidence from adult studies shows deleterious associations of prolonged sedentary time with, for example, waist circumference and fasting plasma glucose (Healy, Matthews, Dunstan, Winkler, & Owen, 2011). Kim, Welk, Braun, and Kang (2015), among others, have suggested paying special attention to sedentary time of longer than 10 min as bouts longer than that have been associated with increased cardiovascular risks among adults.

Context also affects how active children are. Gray et al. (2015) concluded in a systematic review that children aged 3–12 years with higher outdoor time engaged more frequently in moderate and vigorous physical activity and less frequently in sedentary behaviour than children who spend less time outdoors. Similarly, children were more physically active and less sedentary when they were outside than indoors (Gray et al., 2015). Schools, therefore, have an important role and can increase physical activity levels by promoting physically active commuting to school, offering more physical education lessons, encouraging physical activity during recess, and integrating physical activity into academic lessons (Orlowski, Lorson, Lyon, & Minougan, 2013). In addition, moving from the classroom to teach outdoors is a means to organise teaching in a more physically active and less sedentary way (Kahan, 2008).

Nature can be considered to be an enriching environment where children have many opportunities for learning which link abstract thinking and physical activity (Fiskum & Jacobsen, 2012a; Mygind, 2007). Outdoors, children have possibilities to take risks and be confident explorers while satisfying their need for challenge and excitement (Maynard, Waters, & Clement, 2013). Waite, Bølling, and Bentsen (2016) defined outdoor learning as ‘a broad range of purposes and methods, including serendipitous and non-taught learning that are commonly reported in outdoor contexts’ (p. 2). Outdoor learning represents a learner-centred pedagogical approach in which the social and environmental contexts play important roles and foster greater coconstruction of learning. However, children are spending decreasingly less time playing outdoors in neighbourhoods and especially in natural environments, while they have less time to play outdoors as they participate in indoor organised sports and leisure activities and spend much time doing homework (Skar, Wold, Gundersen, & O’Brien, 2016). Parents, therefore, suggested that public institutions, such as schools, should take a more active role in increasing children’s opportunities for nature experiences (Skar et al., 2016). Waite (2010) also noted a decline in the provision of outdoor-learning opportunities in primary schools and argued that the national curriculum’s focus on core subjects creates pressure on the broader curriculum and that playful learning is less popular than more direct taught learning.

Outdoor learning and physical activity

In a seminal review of the outcomes of outdoor learning, Rickinson et al. (2004) described three types of outdoor learning: fieldwork and outdoor visits, outdoor adventure education, and school ground/community projects. The focus of this article is most closely related to fieldwork and outdoor visits, where learning activities often are linked with particular curriculum subjects in outdoor settings. Rickinson et al. (2004) concluded that fieldwork and outdoor visits offer learners opportunities for knowledge and skills development in a way that extends the everyday experiences in the classroom. In a more current review, Bowler, Buyung-Ali, Knight, and Pullin (2010) concluded that ‘apart from the promotion of physical activity’ (p. 2), the natural environment has direct and positive impacts on emotional well-being. Furthermore, in several recent outdoor-learning studies, both teachers and students reported benefits such as social development (Harris, 2017; Hartmeyer & Mygind, 2016; Humberstone & Stan, 2011), enjoyment, and increased motivation (Dettweiler, Ünlü, Lauterbach, Becker, & Gschrey, 2015; Fägerstam, 2014; Fägerstam & Blom, 2013; Fiskum & Jacobsen, 2012b). Furthermore, Waite et al. (2016) argued that regular physical activity in nature, such as climbing, balancing, sliding, building shelters, and using a variety of tools, not only provides opportunities for the development fine- and gross-motor control skills but can also result in clear improvements in children’s physical development. However, only one fifth of the surveyed teachers in the United Kingdom noted the health benefits of outdoor-

learning activities (Waite, 2010). Similarly, research on the impacts of outdoor learning on physical activity is lacking (Rickinson et al., 2004).

In one of the few existing studies about physical activity during outdoor learning, Mygind (2007) conducted a case study objectively measuring students' physical activity levels using accelerometers and compared their physical activity levels during outdoor-learning days in the forest to traditional school days with and without physical education lessons. Mygind (2007) observed that students' mean activity expressed as counts per second was more than twice as high on the forest days than the traditional school days. A school day with physical education lessons had similar results to a school day with outdoor learning. However, Mygind (2007) did not distinguish between activity levels or measure sedentary time, and data were missing for many students.

In another comparative study, Fiskum and Jacobsen (2012a, 2012b) observed 12 fifth-grade students on four days with indoor teaching and three days with outdoor teaching. The researchers used systematic observations of students' physical activity during four segments of the day and rated it on a three-level scale: sitting or standing (*low*), walking (*medium*), and more active than fast walking (*high*; Fiskum & Jacobsen, 2012a, 2012b). Aligning with Mygind (2007), physical activity levels were higher during days with outdoor education (Fiskum & Jacobsen, 2012a, 2012b). In addition, boys were more physically active and exhibited greater differences in indoor and outdoor contexts. Although these studies assessed physical activity with direct observation and accelerometer readings of total physical activity, other studies used heart rate measurements and also recorded higher physical activity levels during outdoor-learning experiences (Dettweiler et al., 2015; Grønningsæter, Hallås, Kristiansen, & Nævdal, 2007). Several researchers, though, have called for more sophisticated analyses of physical activity measurements during outdoor learning in school settings (Dettweiler et al., 2015; Fiskum & Jacobsen, 2012a; Raustorp et al., 2012; Ridgers, Knowles, & Sayers, 2012).

The influence of outdoor-learning environments on students' physical activity and sedentary behaviour, especially among preschool students who spend more time outdoors than primary school students, has received attention. Although researchers (e.g. Maynard et al., 2013; Raustorp et al., 2012; Vanderloo, Tucker, Johnson, & Holmes, 2013) have reported significantly higher observed and objectively measured physical activity levels in outdoor than indoor preschool settings, preschoolers still engaged in sedentary activities about half the time (Berg, 2015; Dymont & Coleman, 2012; Vanderloo et al., 2013). In Dymont and Coleman (2012, p. 95) study, however, teachers believed that the children were actively moving most of the time. Every teacher, therefore, has a significant role in creating learning experiences that promote physical activity (Kos & Jerman, 2013; Waite et al., 2016). Environmental factors, such as playground design and the natural environment, may also influence children's physical activity behaviours. Although Zamani (2016) noted multiple cognitive play opportunities in natural environments, Storli and Hagen (2010) reported no differences in levels of physically active play in a traditional playground environment and a natural environment. However, Fjørtoft (2001, 2004) observed significant improvements in the coordination and balance skills of preschoolers who daily played in the forest and on traditional playgrounds.

Considering the potential of outdoor learning to increase physical activity and reduce sedentary behaviour and the lack of research exploring these themes in primary schools (Gray et al., 2015), this study aimed at examining the influence of outdoor learning on primary students' physical activity and sedentary time. This study compared students' physical activity levels and sedentary time during outdoor-learning and traditional school days. We hypothesised that students engage in more light-, moderate-, and vigorous-intensity physical activity and less sedentary time during outdoor learning. The study specifically addressed the following research questions: (a) What are students' physical activity levels and sedentary time during outdoor learning and traditional, indoor school days? (b) How do outdoor-learning and traditional school days affect leisure-time physical activity and sedentary time? This study contributed to research on school physical activity by exploring the possible effects of school-based outdoor learning.

Methods

Participants and setting

The study population consisted of students from one small primary school purposefully selected based on how teachers implemented and integrated outdoor learning into the regular school day. This primary school in a rural village approximately 50 km from a university had 21 students, 10 girls and 11 boys, in grades 1–6. The students were organised into two learning groups in separate classrooms, with 12 students in grades 1–3 and nine students in grades 4–6. Five students were in first grade, two in second grade, five in third grade, two in fourth grade, four in fifth grade, and finally, two in sixth grade.

The two teachers from the two learning groups had master's degrees in education and were qualified as classroom teachers in Finland. During teacher education, Joel (pseudonym) specialised in physical education and biology, and Heidi (pseudonym) in early childhood education and *sloyd* (handicraft-based education). Joel had 15 and Heidi 19 years' experience as classroom teachers. The teachers were instructed to go about their duties as usual during the two weeks of data collection. They did not participate in the data collection.

The schoolyard was approximately 5,000 m² and had a climbing frame, swings, and a rink where students could skate during the winter and play ball games in the fall and spring. The schoolyard lacked clear boundaries, such as fences, and students were allowed to play in small woods next to the schoolyard during recess. In addition, teachers were permitted to use a large forest area for outdoor learning.

The process of ethical approval for the study started with a meeting with the school principal to present an overview of the proposed study. The principal and the teachers gave approval for the study before it was started. An informed consent letter was sent home to the students' parents describing the study and stating that the participants could withdraw from it at any time. The parents of all 21 students granted permission for their children to participate.

Procedure

Examples of the schedule and content of a traditional school day and an outdoor-learning school day are given in [Tables 1](#) and [2](#). The school day started at 8.00. During traditional school days, grade 1–3 students finished at 12.15, whereas grades 4–6 students finished at 14.00. However, on Friday, the whole school finished at 12.15. During outdoor-learning days, the students were integrated into one group for outdoor instruction, and they all started at 8.00 and finished at 12.15. Teaching during indoor days involved teacher-centred instruction, reading, silent work, group work, and practical activities in all the curriculum subjects (see [Table 1](#)). During these days, the teachers typically explained the content and procedures to the whole class, and the students then worked individually in workbooks. Traditional school days had three 45-min lessons, separated by 15-min recesses in the morning. Next came a 25-min break for a warm lunch, followed by a 20-min recess. In the afternoon, grades 1–3 students had one lesson, while grades 4–6 students had three lessons separated by recesses.

The outdoor-learning days were part of the regular curriculum, and the teachers integrated elements of all the school subjects into these days. The teachers' pedagogical approach can be considered a mix of *udeskole* and forest school outdoor learning. *Udeskole* is a bottom-up educational grassroots movement which builds the personal initiative of passionate teachers or enthusiastic schools moving some instruction from the classroom to the nearby outdoor environments (Waite et al., 2016). Being a part of compulsory curriculum and teaching, *udeskole* aims to provide various academic-, social-, motivational-, and health-related concepts as well as promoting concentration, learning, and support for pupils' academic outcomes. *Udeskole* often

Table 1. Example of a traditional school day, Monday in October.

Time	Grades 1–3	Comments	Grades 4–6	Comments
8.00–8.45	Swedish	Traditional teaching with students at their desks	Swedish	Traditional teaching with students at their desks
8.45–9.00	Recess	The most attention was given to new recess toys (jump ropes, balls)		
9.00–9.45	Mathematics	Traditional teaching with students at their desks	Mathematics	Traditional teaching with students at their desks doing workbook assignments
9.45–10.00	Recess	Playing with new recess toys (girls and boys), swinging (girls and boys), playing in the forest (some boys)		
10.00–10.45	Finnish (grades 1–2) Environment and science (grades 3)	Traditional teaching in Finnish Students at their desks doing workbook assignments	Environment and science (grade 4) Mathematics (grades 5–6)	Students at their desks doing workbook assignments
10.45–11.10	Lunchtime	Free warm lunch		
11.10–11.30	Recess	Playing horses (girls and one boy), swinging (girls and boys), jumping ropes (girls), playing with new balls (girls and boys)		
11.30–12.15	Religion	Traditional teaching with students at their desks	Physical education	A walk in the forest and village, followed by reading the workbook
12.15–12.30	Recess (grades 4–6)	Swinging (boys), playing in the forest (girls and boys), playing ball games (girls and boys)		
12.30–13.15			Physical education	Indoor ball games and other games
13.15–13.30	Recess (grades 5–6)	Jump rope (girls), swinging (girls and boys), playing in the forest (boys)		
13.30–14.15			Swedish	Reading the workbook

Table 2. Example of a school day with outdoor learning, Wednesday in September.

Time	Grades 1–6	Comments
8.00–8.35	Free play and preparation	The students played in the schoolyard (i.e., ball games, swinging, jumping rope).
8.35–9.00	Walking to the forest and free activity	The students had free time in the forest until they were all ready for group activities. The students worked on their huts.
9.00–9.25	Ball game	All the students played a running game together.
9.25–10.10	Sloyd	The students sat at the campfire and carved their pens.
10.10–10.30	Ball game	The students played a catching game, and some students were more active than others.
10.30–10.45	Reading	The students read their workbooks at the campfire.
10.45–11.15	Lunchtime	The students brought their vessels from their huts, washed their hands, and stood in line to receive food. They sat and ate around the campfire, on stumps, and in their huts. When they finished eating, they were allowed to play.
11.15–11.30	Teacher information and free play	The teacher informed the students what would happen next, and the students then had a few minutes of free play. Some students made their own javelins from long sticks and practiced throwing, and others sat in their huts, while some played a game of chase.
11.30–12.00	Reading and game	The students read their workbooks at the campfire and then played a game about animal life in the forest.
12.00–12.15	Back to school	After a closure with the whole group, the students walked back to school.

has cross-disciplinary content related to knowledge and understanding of particular settings, people, and activities in the local environment. Forest schools offer generally recurring occasions for students to connect with nature by providing periods of time outside the classroom in natural spaces during the school week (Waite et al., 2016). In a forest school, students build shelters, cook on camp fires, use woodworking tools, identify plant and wildlife, and participate

in activities such as games to encourage interaction (Harris, 2017). They are expected to learn at their own pace by engaging in various activities that can be linked back to objectives from the national curriculum, which includes understanding science, technology, and mathematics (O'Brien & Murray, 2007). The outdoor-learning days started with student free-play in the schoolyard while the teachers had time to prepare for the day (see Table 2). All the students then walked to the forest as a group, and when they arrived, the teachers gave instructions for the day. During the first day, the students built a campsite with small huts, windbreaks, and a campfire. The outdoor-learning days involved free and teacher-organised play, cooperative learning tasks, orienteering, a *sloyd* (woodwork) task to carve pencils from material found in the forest, reading the workbook, studying animals and plants in the forest, and eating lunch at the campfire. On the last day, the students completed their *sloyd* projects and helped pack up materials and clean up the campsite. Most students were familiar with outdoor learning as the school held an outdoor-learning week every semester and spent one day every month in the forest.

Data collection

The students' physical activity and sedentary time were measured with accelerometers, and the content of and the participants' behaviour during school days were evaluated through nonparticipant observation. This mixed methods research approach was selected to support quantitative data with qualitative data, thereby generating a more complete understanding of the students' physical activity and the impacts of outdoor learning (Lund, 2012).

Physical activity data collection

Physical activity and sedentary time were measured with accelerometers (GT3X+ and wGT3X+, Pensacola, Florida, USA). The students wore monitors on the right hip during waking hours for seven consecutive days, except while doing water-based activities. The monitors collected data in raw 30 Hz mode. Accelerometer data were processed in 15-second intervals using a customised Visual Basic macro in Microsoft Excel software. A valid measurement period was defined as monitor worn at least 500 min/day between 7.00 and 23.00 for at least three traditional school days and three days of outdoor-learning days (Cooper et al., 2015). Monitor use during at least 80% of school hours was required. Weekend days were not included as the emphasis of the study was on school days. Non-wear time was defined as 30 or more minutes of consecutive zero counts, whereas more than 20,000 counts per minute (cpm) were considered to be spurious data and not included in the analysis (Heil, Brage, & Rothney, 2012). The steps and time spent for the levels of intensity (sedentary: ≤ 100 cpm, light: 101–2295 cpm, moderate: 2296–4011 cpm, and vigorous: ≥ 4012 cpm) were analysed using the cut points defined by Evenson, Catellier, Gill, Ondrak, and McMurray (2008). Light intensity was divided into two categories (light1: 101–1197 cpm, light2: 1198–2295 cpm) to allow closer examination of light-intensity activities. Sedentary periods lasting more than 10 min (Sed10s) were calculated. The duration of school days varied, so the time spent at different intensity levels was expressed as minutes per hour.

Non-participant observation

The purpose of nonparticipant observation during the school day was to provide the researchers with opportunities to understand the teachers' and the students' behaviour at school and to enable comparisons of objectively measured physical activity data with what actually took place. The second author was present at the school throughout the data collection and took detailed field notes on the structure and implementation of school days, instructional strategies, students'

responses to the lesson activities, events during recess, and use of the outdoor environment. The observations provided glimpses into schoolwork and students' physical activity through the lens of the researcher.

Data collection in this study was conducted over two weeks from Thursday, 24 September, through Wednesday, 7 October. The students were informed about the data collection procedures the day before actual data collection started. The students then started to wear the accelerometer to get used to the device. The original plan was to observe two days of traditional teaching, five days of outdoor-learning experiences, and then three days of traditional teaching. Unfortunately, during the fourth traditional school day (Tuesday), more than half of the students participated in a school soccer tournament at another school. This day differed greatly in structure and did not represent a routine school day. Therefore, we did not include data from this day in the analysis, leaving four days of traditional indoor teaching.

On average, the students participated in data collection for 3.95 valid traditional school days (294 ± 41 min) and 4.95 outdoor-learning days (254 ± 2 min). During leisure time, the students wore the monitors for 525 ± 45 min on traditional school days and 549 ± 43 min during outdoor-learning days. One sixth-grade girl had only two valid days of traditional school days and, therefore, was excluded from the analysis.

Data analysis

Descriptive statistics were calculated using IBM Statistical Package for the Social Sciences (SPSS) version 20.0 (SPSS Inc., Chicago, IL); in particular, the means and standard deviations for minutes of activity and steps during the school day, leisure time, and the whole day. Due to non-normality, Sed10s for the school day were log-transformed for the analysis. Repeated measures analysis of variance (ANOVA) were performed to assess the differences between traditional school days and outdoor-learning days. To evaluate the differences between the most- and least-active students as measured by number of steps, an independent sample *t*-test was conducted. The significance level of the study was set at 0.05. Due to the small sample size, all the participants were analysed as one group, but gender and age differences were checked. Grades 1–3 students had a bigger step difference between traditional school days and outdoor-learning days than grades 4–6 students, but otherwise, no gender- or grade-level differences in teaching methods were found.

Results

Objectively determined physical activity and sedentary behaviour

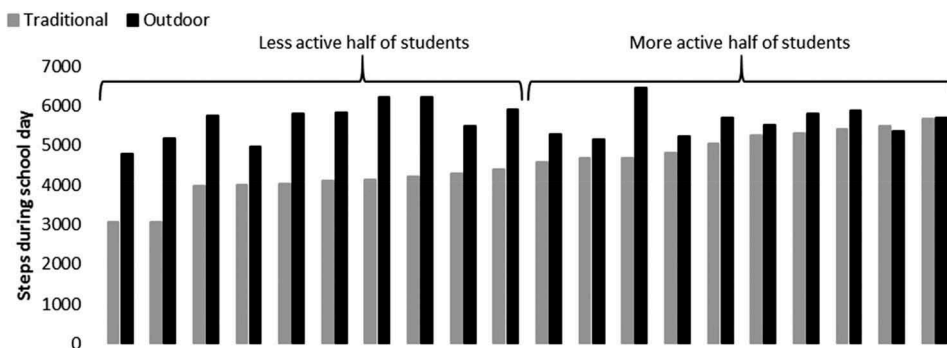
The means and standard deviations for physical activity and sedentary time (minutes per hour) in school and leisure time during outdoor-learning and traditional school days are shown in [Table 3](#).

During outdoor-learning days, the students engaged in less sedentary and Sed10 behaviour and in more light1, light2, moderate-intensity, and MVPA behaviour than on traditional school days. They also performed more total steps on outdoor-learning days. In contrast, no differences in vigorous activity between outdoor-learning and traditional schools days were reported. The time spent on physical activity and sedentary variables increased from 15% to 58% between traditional and outdoor-learning school days ([Table 3](#)). The students were divided into two groups with significant differences ($p < .001$) in the number of steps during traditional school days. Both groups took more steps on outdoor-learning days, but the increase was significantly larger in the less-active group (143% vs. 110%; see [Figure 1](#)). There were no significant differences in physical activity and sedentary behaviours during leisure time on outdoor-learning and traditional school days ([Table 3](#)).

Table 3. School-day, leisure-time, and whole-day physical activity and sedentary time (mean $\pm$ standard deviation) among primary school students ($n = 20$) during traditional school days and outdoor-learning days.

Physical activity	Traditional school days	Outdoor-learning days	Difference (per cent)	P value
School day				
Sedentary time >10 min, min/h	5.98 $\pm$ 4.19	2.55 $\pm$ 1.81	-57%	<0.001
Sedentary time, min/h	33.37 $\pm$ 3.24	26.73 $\pm$ 3.38	-20%	<0.001
Light 1 [*] PA, min/h	15.09 $\pm$ 2.28	17.31 $\pm$ 2.04	15%	<0.001
Light 2 [*] PA, min/h	4.56 $\pm$ 0.76	7.08 $\pm$ 1.34	55%	<0.001
Moderate PA, min/h	3.69 $\pm$ 0.78	5.84 $\pm$ 0.84	58%	<0.001
Vigorous PA, min/h	3.28 $\pm$ 1.15	3.05 $\pm$ 0.84	-7%	0.279
MVPA [*] , min/h	6.98 $\pm$ 1.62	8.88 $\pm$ 1.42	27%	<0.001
Steps	4513 $\pm$ 734	5613 $\pm$ 437	24%	<0.001
Leisure time				
Sedentary time >10 min, min/h	7.24 $\pm$ 4.67	8.08 $\pm$ 4.6	12%	0.187
Sedentary time, min/h	34.91 $\pm$ 5.81	34.93 $\pm$ 4.93	0%	0.979
Light 1 PA, min/h	15.96 $\pm$ 2.53	15.79 $\pm$ 2.43	-1%	0.674
Light 2 PA, min/h	4.66 $\pm$ 1.82	4.79 $\pm$ 1.39	3%	0.599
Moderate PA, min/h	3.00 $\pm$ 1.29	3.13 $\pm$ 1.14	4%	0.569
Vigorous PA, min/h	1.47 $\pm$ 0.84	1.35 $\pm$ 0.74	-8%	0.293
MVPA, min/h	4.47 $\pm$ 2.01	4.48 $\pm$ 1.7	0%	0.979
Steps	6497 $\pm$ 2145	6713 $\pm$ 1759	3%	0.560
Whole day				
Sedentary time >10 min, min/h	6.72 $\pm$ 3.87	6.32 $\pm$ 3.53	-6%	0.460
Sedentary time, min/h	34.3 $\pm$ 4.46	32.35 $\pm$ 3.96	-6%	<0.01
Light 1 PA, min/h	15.67 $\pm$ 2.08	16.26 $\pm$ 2.08	4%	<0.05
Light 2 PA, min/h	4.66 $\pm$ 1.36	5.51 $\pm$ 1.14	18%	<0.001
Moderate PA, min/h	3.26 $\pm$ 0.97	3.99 $\pm$ 0.94	23%	<0.001
Vigorous PA, min/h	2.12 $\pm$ 0.84	1.89 $\pm$ 0.67	-11%	0.079
MVPA, min/h	5.38 $\pm$ 1.62	5.88 $\pm$ 1.48	9%	<0.05
Steps	11,009 $\pm$ 2321	12,326 $\pm$ 1900	12%	<0.01

Sedentary time >10 min: sedentary periods lasting 10 min or longer; Light 1: 101–1197 cpm; Light 2: 1198–2295 cpm; MVPA: moderate and vigorous physical activity; PA: physical activity.

**Figure 1.** Individual results for steps during the school day presented in order by least-to-most steps taken during traditional days (grey: traditional school day, black: outdoor-learning day).

Process observations

During traditional school days, the students typically sat at their desks working on different tasks in each school subject. The only school subjects that broke from this pattern were physical education and *sloyd*. In addition, on one occasion, the grades 4–6 teacher was observed to implement a functional teaching method during a religion lesson as students walked around the gym and responded to questions at different locations. During outdoor-learning days, the students also sat regularly but for shorter periods. They occasionally gathered around the campfire, where they were given information about what to do next. At times, the students sat inside the huts they had built

during earlier outdoor-learning experiences. The students were sedentary while eating lunch in the forest but were still freer to move than while eating in the dining room at the school. During some lessons, students had longer sedentary periods even in the forest. At these times, the students read their workbooks in their huts during mother language lessons and carved wooden pencils in *sloyd* lessons. During outdoor-learning days, students walked to and from the forest in a light-intensity physical activity. Activities in the forest that provided light physical activity included organising the tents, wind shelters, and huts in the camp and refining and cleaning their own huts, as well as group dynamics games and free play. Normally, all the students worked as one large group in similar activities.

The traditional school day was typically divided into classroom lessons and recess. The school had a large schoolyard, and during recess, the students were allowed to go on the playground and in the nearby small grove. In this small school, all the students had recess at the same time, and in the observations, students from all grade levels played together. For example, on a few occasions during recess, all the students played the game 'the ball in the can' together. These recess opportunities allowed the students to be physically active during traditional school days. During the recess observations, the students, for example, climbed trees, built huts, jumped rope, and played hide-and-seek and ball and running games. The students' physical activity intensity levels ranged from walking to fast running, with large individual variations. In addition, some students were very active during recess. In the horse game, for example, most of the girls and some boys participated. Some students were horses, while the rest were grooms. The horses needed to be walked every day, and the students ran around in 'the ring' (the hockey rink). Other running games during recess also provided opportunities for students to reach higher intensity levels of physical activity.

Physical education lessons allowed the students to be physically active at a high intensity two times a week during traditional school days. These lessons were organised and instructed by the teacher, and all the students participated in similar activities. Additionally, the students could move at higher intensity in running games and orienteering activities during outdoor-learning days.

Some students showed large variations in moderate- and vigorous-intensity physical activity on traditional school and outdoor-learning days. The observations showed that these students did not voluntarily engage in physical activities that would reach a high level of intensity. These students were more physically active on traditional school days, with the structure of physical education lessons and recess. During outdoor-learning days, the environment for physical activity was more inviting but also more open, so the students could choose how much effort to put into activities. Therefore, the students who did not put much effort into physical activity had an opportunity to stay on a lower intensity level, while those who wanted could make the same effort as on traditional school days.

Discussion

To date, few studies have examined the influence of an outdoor learning-teaching approach on primary school students' physical activity. Most existing studies have focused only on changes in overall physical activity during school days (Dettweiler et al., 2015; Fiskum & Jacobsen, 2012a; Grønningsæter et al., 2007; Mygind, 2007). The current study, therefore, adds to the limited literature in this area and is the first to examine changes in both sedentary time and physical activity, including analyses of different intensity levels of students' physical activity and leisure-time physical activity.

One study aim was to investigate the influence of the outdoor-learning approach on students' sedentary time and light-, moderate-, and vigorous-intensity physical activity in comparison to traditional teaching. The most obvious finding is that, in the outdoor-learning setting, the students showed significantly higher physical activity levels than during traditional teaching. This finding corresponds well with previous outdoor-learning research conducted in various contexts using different research methodologies (Dettweiler et al., 2015; Fiskum & Jacobsen, 2012a; Grønningsæter

et al., 2007; Mygind, 2007). In this study, the students engaged in 15% more light-intensity activities, 55% more light2 activities, and 27% more MVPA, and they took 24% more steps during a school day during outdoor learning than a traditional school day. The greater light-intensity physical activity in the outdoors indicates that changes in the environment can be especially beneficial for light-intensity activities.

This finding illustrates that physical activity is connected to teachers' pedagogical choice of learning approach. The observation data further show that the students walked to the forest, worked to organise the camp, and engaged in cooperative group games and free play. If we consider the objectively measured physical activity data and the qualitative observations, we can easily see that the students enjoyed the practical orientation in outdoor learning and accordingly were more physically active. However, the implementation of this educational curriculum needs to be highlighted. According to the definitions and theoretical assumptions for outdoor learning, traditional and outdoor learning will show distinct features. Furthermore, in Finland, a teacher's professional autonomy in integrating outdoor learning with classroom practice is accepted (Sahlberg, 2007). The teachers are responsible for identifying the curriculum areas of learning that would benefit from being taught outside the classroom, while concurrently addressing and attaining the prescribed educational requirements of the Finnish curriculum. Moreover, in addition to the pedagogical approach implemented by the teachers, the natural environment (Waite et al., 2016; Zamani, 2016) and the relaxed, child-centred atmosphere (Maynard et al., 2013; O'Brien & Murray, 2007; Waite, 2010) in outdoor settings might contribute to changes in the students' physical activity behaviour.

However, the students spent less time in vigorous physical activity during outdoor-learning days, which is a somewhat surprising result. It might result from the different structure of the school day in these two environments. First, outdoor-learning days did not include any physical education lessons, which have been reported to consist on average of 40% MVPA and 9% vigorous-intensity physical activity, with large individual variations among students (Fairclough & Stratton, 2005; Romar, Nygård, Smedman, & Hannon, 2014; Singerland, Oomen, & Borghouts, 2011). In addition, Mygind (2007) found that students engaged in similar physical activity levels during outdoor learning and during a traditional day with two physical education lessons. Second, the traditional Finnish school day in primary school, as at this school, includes outdoor recesses every 45 or 90 min (Haapala et al., 2014). Previous research has shown that recess has positive impacts on students' physical activity during school days (Blaes et al., 2013; Carlson et al., 2013). Our observations support that the recess breaks at this school involved more intense games and play that reached vigorous-intensity physical activity levels. However, in some observations, some students took advantage of the freer and more relaxed environment during outdoor learning, compared to the traditional environment, and engaged in less intense physically active behaviours. Finally, regarding physical activity, the students' had on average 36 min of MVPA during outdoor-learning days and 36 min of MVPA during leisure time outside school hours. Despite lower levels of vigorous-intensity physical activity during outdoor-learning days, these results show that the school was more effective at providing physical activity than the home environment although the students spent less time in school.

We extend the existing outdoor-learning literature by reporting sedentary and light-intensity physical activity, in addition to overall activity, across two settings for the entire school day. Our main finding in this area is that sedentary time decreased by 20% and Sed10s by 57% on outdoor-learning days. This is a significant decrease in the students' sedentary time during the school day and suggests that changes in the teachers' pedagogical approach can had positive effects on the students' sedentary time. Other solutions to reducing sedentary time during classroom lessons are activity breaks during class time and listening to lessons while standing or sitting on stability balls (Braniff, 2011; Helgeson, 2011; Orłowski et al., 2013). Growing evidence shows that changing from sitting to light-intensity physical activities contributes to an increase in overall physical activity

energy expenditure and can be a practical, realisable strategy to reduce health risks (Healy et al., 2008; Owen, Healy, Matthews, & Dunstan, 2010).

However, the students were sedentary in both school settings for more than 45% of the school day; thus, being sedentary was the primary school students' dominant behaviour. Accordingly, our results for traditional school days match previous findings from Finnish primary school students in general (Haapala et al., 2016). Based on our study results showing that sedentary time decreased during outdoor-learning days, we agree with other researchers and educators (Haapala et al., 2016; Hegarty, Mair, Kirby, Murtagh, & Murphy, 2016) who argue that decreasing sedentary time needs to be a focus in primary schools. The field notes recording observations of daily teaching routines showed that, during traditional teaching, the students were expected to sit at their desks while listening to the teacher or working in their workbooks, a method that Haapala et al. (2016) suggested to be changed. During outdoor learning, the teachers planned and organised instruction in different ways, which created a diverse structure for students to participate in learning activities.

Dividing the students into two subgroups based on their steps during traditional school days showed that the group with fewer steps increased their step count more on outdoor-learning days than the group with initially more steps. The pedagogical structure and the natural environment, therefore, are suggested to be especially effective at increasing physical activity levels for students with lower physical activity levels in traditional school settings. This is an important finding, responding to researchers' and intervention programmes' calls to promote physical activity among inactive children (Hegarty et al., 2016; Strong et al., 2005). As the observations indicate, the students were sedentary, sitting at their desks during traditional school lessons, and were physically active during recess. However, some students were more active while others were less active, as evident in the large variance in students' steps during traditional school days. During outdoor-learning days, physical activity was not scheduled during certain time periods (recess); instead, students were freer to move around, which was evident in less variance in the amount of steps.

To our knowledge, the influence of outdoor-learning and traditional teaching on objectively measured physical activity during leisure time has not been reported. However, research on primary school children's leisure time has indicated a compensation effect as high physical activity level in school results in lower physical activity during leisure time (Haapala et al., 2016; Møller et al., 2014; Ridgers, Timperio, Cerin, & Salmon, 2014). Therefore, in this study, it was slightly unexpected that the increased physical activity during the school day showed no negative effects on leisure time physical activity. One can expect that, after being outdoors for the whole school day, the students might prefer time for indoor activities, such as homework (Skar et al., 2016) and using computers or other devices with screens (Yang et al., 2017). The findings from the current study, though, provide further evidence that the positive physical activity outcomes of outdoor learning did not negatively affect leisure time activity differently than the demands of a traditional school day. This finding might be the result of the school's rural location, where the students were used to being outdoors during the school day as well as during leisure time.

This study is among the first to use objective measures to describe primary school students' physical activity and sedentary time during outdoor-learning and traditional school days. The strength of the study is the combination of objective measurements of physical activity and qualitative analyses of the school day. In addition, we collected whole-day data, and only one student was omitted due to insufficient data recordings. However, the study has several limitations that warrant attention. First, the findings are not generalisable due to the small sample size and the examination of only one school. Second, the small sample did not allow for analysing the effects of gender and age. Third, the school days were not broken down into specific pedagogical sections, nor was academic learning investigated. Finally, we did not systematically observe the social dynamics created by the intervention and students' reactions to the intervention.

The challenge for future research is to replicate this single-case study across a number of different settings. Additional research exploring the influences of outdoor learning from a more holistic approach could provide further understanding by examining the impacts on students'

social, cognitive, and affective learning outcomes also in a longer perspective. It could also be interesting to gather qualitative data on students' perceptions of the effects of outdoor learning on sedentary and physical activity behaviour.

Conclusion

Despite these limitations, this study extends the literature on outdoor learning and physical activity research. The study suggests that moving from traditional classroom teaching methodologies to an outdoor-learning environment decreases students' sedentary time and increases their light- and moderate-intensity physical activity during the school day. In addition, no difference was observed in the students' leisure-time physical activity on outdoor-learning and traditional school days, supporting the social and ecological validity of this approach. The implication from this study is that outdoor learning is an effective complement to traditional classroom teaching in promoting physically active children.

The results provide guidance for researchers, practitioners, parents, school communities, and policymakers on opportunities to increase children's physical activity and reduce their sedentary behaviour. Our findings about physical activity and sedentary behaviour support pedagogical approaches that highlight the educational value of outdoor learning and integrate it into the curriculum, an approach that similarly confirms students' physical activity promotion, as Gray et al. (2015) also concluded. The results stress the importance of how the school and the teachers pedagogically view the instructional strategies and the environment that young children encounter in primary school. Teachers, therefore, have a central role in implementing educational change and need to receive all the support they can from their surrounding communities.

Disclosure statement

No potential conflict of interest was reported by the authors.

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