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What makes John move? Outdoor play physical environmental factors changing a child's activity from sedentary to physically active: longitudinal mixed-method case study

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ABSTRACT: Children's low physical activity levels call for an investigation of what can promote activity for excessively sedentary children. The purpose of this longitudinal mixed-method case study in an early childhood education (ECE) environment was to observe one sedentary child's free outdoor playtime in four seasons and determine the physical environmental factors changing his activity from sedentary to physically active. Systematic observation of video material and quantitative analysis were used to identify the most sedentary individual of the one ECE group. The child was named "John". Qualitative analysis of John's video material showed that during the four seasons he spent an average of 25% of the playtime doing sedentary activity and 75% of the playtime doing physically active activity during 60-minute free outdoor play sessions. There were a total of 71 physical environmental factors related to John's change in outdoor activity in the various seasons: man-made

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objects, such as play equipment, observed 28 times (39%); natural materials, such as water, sand and snow, observed 25 times (35%); and free spaces in the yard observed 18 times (26%). The number of factors was highest in the summer and lowest in the spring. Seasonal changes and conditions unique to Scandinavia may make outdoor play environment in ECE physically activating.

Keywords: *physical activity, outdoor play, physical environment, observation*

Introduction

Physical activity as play

Physical activity is defined as any bodily movement that results in energy expenditure (Caspersen et al., 1985), whereas sedentary behaviour is defined as any waking behaviour characterized by an energy expenditure of less than or equal to 1.5 metabolic equivalents (METs) while in a sitting, reclining or lying posture (Tremblay et al., 2017). Physical activity and sedentary behaviour can consist of multiple different types of behaviours. For instance, physical activity may be realized as organized hobbies, active play or hiking in nature, whereas sedentary behaviour may be realized as screen time, playing still or reading. These different types of behaviours can occur in multiple settings, such as home or ECE (Gubbels et al., 2014). Increased time participating in sedentary behaviour is associated with negative health consequences, such as unhealthy weight gain, risk of chronic diseases and cognitive learning difficulties, although high levels of daily physical activity may eliminate these risks (Tremblay et al., 2017). Sedentary habits are rooted in early childhood and tend to track later in life (Jones et al., 2013).

From the point of view of human development, a child is inherently physically active because he explores the world around him through moving his own body and developing motor skills (Burdette & Whitaker, 2005). It has been suggested that in young children, natural physical activity should be viewed as play (Burdette & Whitaker, 2005; Timmons et al., 2007). Play is an essential component of child development, and it is defined as "engaging in an activity for enjoyment and recreation rather than a serious or practical purpose" (Oxford Dictionary, 2020). Play promotes a child's overall development as it helps the refinement of physical skills (e.g., fundamental motor skills, motor coordination and muscle strength) and fosters social development, self-conception, and creativity (Johnstone et al., 2017; Pellegrini & Smith, 1998; Pesce et al., 2016). According to Pellegrini and Smith (1998), children's play often has a vigorous physical component and, therefore, may alternatively be called exercise play, physical activity play or locomotor play. Active play has been viewed as a new and encompassing approach to physical

activity promotion as it does not require a high degree of structure or an adult to lead, and the intention is not to increase physical activity and skills but to have fun (Truelove et al., 2017). Active play is defined as a "form of gross motor or total body movement in which young children exert energy in a freely chosen, fun, and unstructured manner" (Truelove et al., 2017, p. 164).

The natural physical activity, also called play (Burdette & Whitaker, 2005; Timmons et al., 2007), of a young child is characterized by rapid variability and randomness, which places certain demands on its study. Direct continuous observation of an individual has been considered the most accurate and informative method to study young children's natural physical activity. It has also been used for calibration of other physical activity measurement tools (Trost, 2007.)

Children need physical activity

Sufficient physical activity is necessary for the health, overall development and well-being of young children (World Health Organization, 2019), and it is prescribed by the Finnish Act on Early Childhood Education and Care (540/2018, 3§). Adopting a physically active lifestyle must be realized from a young age because physical activity levels track from early childhood to later childhood and adolescence (Lounassalo et al., 2019). The period of early childhood is a time of rapid growth and overall development, including significant brain development as well as development of physical, social and psychological domains of life (Malina, 2014; Shonkoff, 2014). As it is, the early childhood education (ECE) setting is critical for promotion of a physically active way of life because 74% of 1 to 6 year olds spend a significant proportion of waking time in these settings (Finnish Institute for Health and Welfare, 2018). With enrolment rates high, the ability of ECE to influence many children's development and learning in a way that promotes joy of movement and good health across their life spans is significant (Jones et al., 2019).

Finnish recommendations for physical activity in early childhood (2016) are founded on the United Nations' Convention on the Rights of the Child (1989). Recommendations are based on scientific evidence of how adults interacting with children under eight years old can facilitate the realisation of the rights of children by comprehensive support of their growth, development, health and well-being through physical activities (Finnish recommendations for physical activity in early childhood, 2016).

According to recommendations, a child needs at least three hours of physical activity with varying intensity levels every day, comprising light physical activity, brisk outdoor activities, and vigorous physical activity (Finnish recommendations for physical activity in early childhood, 2016). Physically sedentary periods should not last longer than an

hour; even shorter periods of inactivity should be broken up with something that the child finds enjoyable. The child should practice fundamental motor skills every day in a variety of ways and environments and in all seasons of the year (Finnish recommendations for physical activity in early childhood, 2016). Despite these recommendations for the promotion of children's physical activity in ECE, research shows that children's ECE days are physically quite passive (Finland's Report Card, 2018); children spend 50–60% of the day in physically sedentary activities, and the majority of the physical activities consist of very light to light physical activities, leaving the proportion of moderate-to-vigorous physical activities at only a few percent (Finland's Report Card, 2018; Matarma et al., 2018; Määttä et al., 2019).

Significance of outdoor play to increase physical activity

Physical activity and sedentary behaviours are complex and influenced by multilevel factors interacting to facilitate or hinder physical activity and sedentary behaviours in young children (Malina, 2014). The social-ecological model (Bronfenbrenner, 1979) has been extensively used to help professionals and researchers identify and understand how the various multilevel influences interact to form individuals' physical activity opportunities and choices (Gubbels et al., 2014; Määttä et al., 2016; Mehtälä et al., 2014). The model helps identify the individual (e.g., gender, age, motor skills and temperament); social-environmental (e.g., family and educators); and physical-environmental (e.g., availability of physical activity and facilities) factors that may influence one's ability to be sufficiently physically active (Mehtälä et al., 2014).

A review on correlates of physical activity and sedentary behaviour in ECE concluded that the physical environment had the most significant influence (Tonge et al., 2016). Especially outdoor play opportunities were found consistently associated with less sedentary behaviour and increased physical activity (Tonge et al., 2016). Outdoor play has other developmental benefits: Children have increased opportunity to engage in gross motor movement and use their emerging fundamental motor skills, such as running, jumping, throwing, catching and kicking (Niemistö et al., 2019). In addition, children are able to explore their natural environment and learn to appreciate the outdoors, while also demonstrating resiliency, self-regulation and the ability to socialize with peers, developing skills for dealing with stress later in life (McCurdy et al., 2010; O'Brien, 2009; Zamani, 2016). Although time spent outdoors has been found as a promising way to increase children's physically active time and decrease physically sedentary time while in ECE (Tonge et al., 2016), a recent study showed that even during outdoor play sessions, children were mostly physically sedentary (Truelove et al., 2018). Studies suggest it is the quality of the outdoor environment rather than the quantity of time spent outdoors that

appears to be crucial for children's physical activity and sedentary behaviour. It seems that certain elements of the outdoor environment (e.g., size, use of and presence of portable play equipment, like bikes, balls, natural material, and access to forestry spaces) may be associated with increased physical activity, but findings are mixed and inconsistent (Cardon et al., 2008; Dankiw et al.,2020; Gubbels et al., 2012; Ng et al., 2020; Tonge et al., 2016).

Need for individual-level research

Children are active agents, shaping and interpreting their environment. Their individual characteristics influence how they act in the environment (Scarr, 1992). Research indicates there are significant differences among individual children's outdoor playtime physical activity and sedentary behaviour in ECE (Gubbels et al., 2014; Iivonen et al., 2019). This may mean that during outdoor playtime in an ECE day, some children may spent almost the entire time sitting and doing various sedentary physical activities, while some children may spend the same time moving vigorously around the yard and doing moderate-to-vigorous physical activities (Iivonen et al., 2019; Soini, 2015). Longitudinal data also suggest that an individual child's physically active behaviour varies greatly over time, which is reflected in large daily and seasonal variations (Bailey et al., 1995; Fisher et al., 2005; Iivonen et al., 2019; Van Cauwenberghe et al., 2012). Consequently, there is a need for longitudinal observational studies of individual children in order to get a better understanding of children's physically active behaviour change over time and how different physical environmental factors are related (Sallis et al., 2012).

Professionals and researchers are continuously trying to find ways to encourage physical activity in children who spend a lot of time doing sedentary activities in ECE so that they can feel the joy of movement (Jones et al., 2019). One important reason why the efforts have been largely unsuccessful so far is that interventions do not take sufficient account of children's individual factors (Gubbels et al., 2014). Except for gender and age, the impact or relationship of children's individual factors on physical activity and sedentary behaviour in their ECE time has been studied minimally (Gubbels et al., 2014). Nonetheless, previous nascent evidence suggests that a child's individual characteristics may interact with the effect of the ECE outdoor environment, further indicating that different children need different environmental opportunities to be physically active (Gubbels et al., 2018; Ng et al., 2020; Niemistö et al., 2019).

Interestingly, we are not aware of any observational studies that have longitudinally investigated what physical environmental opportunities in the ECE outdoor playtime

would make an individual child who spent a lot of time doing sedentary activities, in general, start doing more physical activities. From the viewpoint of children's inclusion and equality in ECE (Act on Early Childhood Education and Care, 540/2018, 3§), such information would be extremely important for outdoor play environments in the ECE sector to be organized to provide equal physical activity opportunities for all children. These phenomena and research needs drive the purpose of this study.

Aims of the study

The main aim of this longitudinal mixed-method case study was firstly, to analyse one child and his free outdoor playtime in four seasons and secondly, to determine the physical environmental factors changing his activity from sedentary to physically active. The more specific objectives were 1) identifying the individual child in the group of children of an ECE unit who engaged, on average, the greatest percentage of free outdoor playtime in sedentary activity and 2) observing his free outdoor playtime in four seasons to find out the physical environmental factors in an ECE unit yard related to his activity change from sedentary activity (SA) to physically active activity (PAA).

Method

Participants and data collection environment

Convenience sampling was used in this study: One ECE unit in central Finland was selected to participate in the research, because it located a reasonable distance from the university of the researcher who collected the data. The guardians of the children of the ECE unit were asked to sign an informed consent form for their child(ren)'s possible participation in the study. The form provided information on the implementation of the study (including video recording) as well as ethical principles. Altogether, 12 children who had their guardians' consent (four boys and eight girls aged 4–6 years) were told about this study in the ECE unit and their willingness to participate was asked. All 12 children were willing to participate. The data sample consisted 12 children. Within these 12 children, 5-year-old boy turned out to be the child who spent most playtime, on average, engaged in sedentary activity. This child is called now on John. Please see Figure 3.

Yard conditions

The yard of the ECE unit was flat, about 40 by 30 metres (1200 m^2) in size, with a sandbox, a slide, swings, a seesaw, a playhouse and various play equipment in a storage unit, which children were allowed to pick up freely. There were some natural elements, such as eight trees, larger rock, grass, and other vegetation. The ECE unit building (about 20 by 10 metres) was at the other end of the yard (Figure 1).

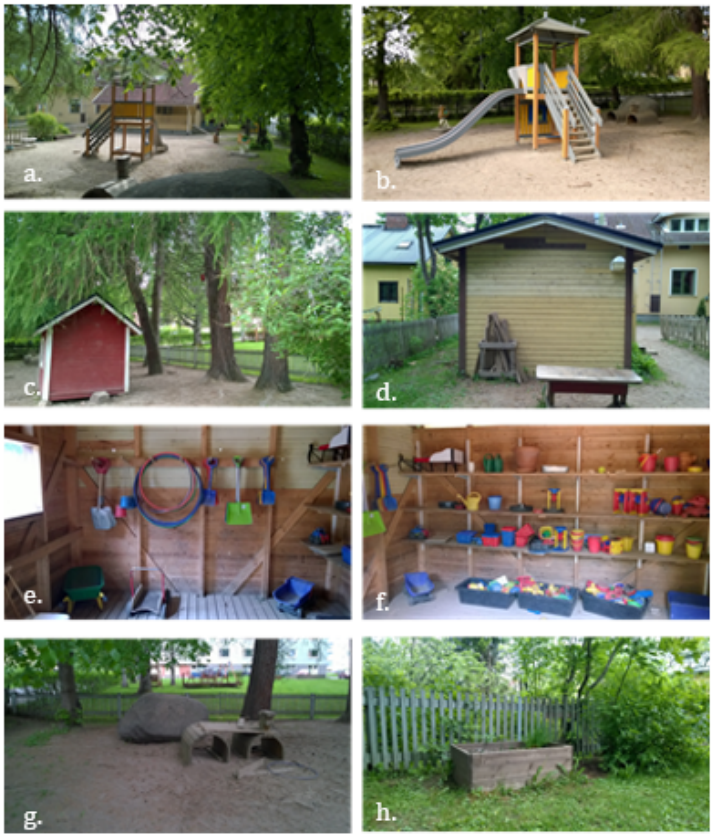

FIGURE 1 Photographs from the yard of the ECE unit: (a) the ECE unit building, (b) slide, (c) playhouse and trees, (d) the equipment storage unit, (e) equipment in the storage unit, (f) equipment in the storage unit, (g) the rock and (h) vegetation

Phase 1: Collection of video material

The video material for this study was collected in the yard of the ECE unit by filming one child at a time with a Sony HXR-MC50 video camera for 60 minutes without interruption. Data collection began at 9 a.m. during the free outdoor playtime according to the daily program of the ECE unit. According to the daily program, free outdoor playtime was scheduled between approximately from 8 to 11 a.m. The duration of the video recordings defined as 60 minutes for each child, as it covered approximately one third of the outdoor

playtime. In addition, it was important to carry out the data collection with the least disturbance to the normal operation of the ECE unit. Therefore, the duration of video recording was limited to 60 minutes. Each child was filmed in the autumn, winter, spring and summer (four times over the course of the year). To maintain a sense of security and familiarity, the same researcher conducted all the video recordings. While filming, the distance between the researcher and the child was 5 to 20 metres. If the child went inside the ECE unit building, filming was stopped and continued once the child had come back to the yard. Because the video recordings were conducted on regular ECE days, surprising factors may have changed the data collection so that data was not obtained exactly 60 minutes from all 12 children. For example, the educator may have stopped outdoor playtime and the children moved inside. The exact average durations of video recordings per child for each season were 59 minutes 20 seconds in autumn, 60 minutes 17 seconds in winter, 58 minutes 28 seconds in spring and 53 minutes 46 seconds in summer. To improve readability, we will report an outdoor playtime of 60 minutes from now on.

Phase 2: Quantitative systematic observation of the video material

The researcher, having observational research experience of young children's physical activity and motor skills, followed the training steps recommended by McKenzie (2002) and conducted all observations of this study. Systematic (direct) observation computer software (Department of Sport Sciences, 2006) with the continuous duration (length) recording technique was used to examine how much time in minutes and seconds each of the 12 children spent in SA and PAA in the ECE unit yard during free 60-minute outdoor playtime in all four seasons (Iivonen et al., 2019). Direct observation based on continuous duration recording was used because it is considered the most accurate and informative physical activity assessment method (McKenzie & van der Mars, 2015; Trost, 2007). This method is especially valuable with young children, whose minute-to-minute variability is extremely high (Bailey et al., 1995). During an observation session, activities (e.g., running) were scored by the researcher's clicking items on the screen at the start of the activity and were ended automatically when an item representing another activity (e.g., sitting) was clicked. The observational data (specific time in seconds) entered directly into an Excel workbook during the events were coded from the video. Figure 2 illustrates the activity recorded in the observation software (Department of Sport Sciences, 2006) that was observed over a period of 60 minutes of free outdoor play by the individual who became the participant-child of this study.

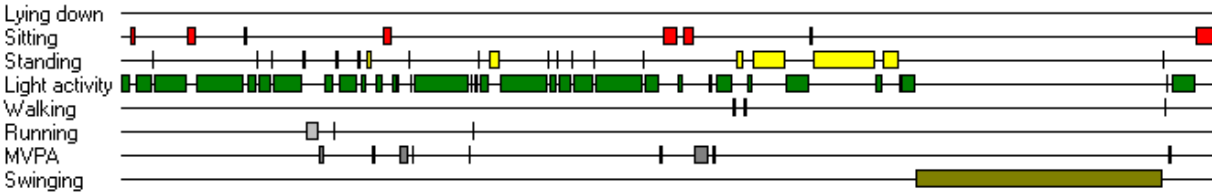

FIGURE 2 Activity of the participant-child over 60 minutes of free outdoor play observed and recorded in the observation software (Department of Sport Sciences, 2006). Light activity = light activities and games; MVPA = moderate-to-vigorous activities and games.

To implement the validity of the categorization of SA and PAA activities, we arranged them in eight mutually exclusive observation categories. Three different observation categories were constructed for SA, and five different categories consisting of fundamental stability, locomotor and manipulative movements typical for ECE-aged children were constructed for PAA (Donnelly et al., 2017, pp. 54–61). This categorization is in line with the research data on the energy cost of these types of activities (Butte et al., 2018). The reliability of the systematic observation was confirmed by two independent observers (SI and DN) observing the same six randomly selected children. The reliability rate of 80% agreement considered necessary for research purposes (Siedentop, 1991, pp. 309–311) was obtained in all observation categories. The observation categories and their interobserver reliability are described in Appendix 1.

Phase 3: Selection of "John" and qualitative observation of his video material (case study)

Video data observed (46 hours, 22 minutes and 17 seconds) from all 12 children was further analysed in Excel workbook by calculating the percentages of free outdoor playtime in four seasons spent by each of the 12 children on SA and PAA. The child who had the highest mean percentage of SA during all seasons was selected as John. The exact durations of the video data that had been observed from him were 29 minutes 5 seconds in the autumn, 59 minutes 38 seconds in the winter, 35 minutes 55 seconds in the spring, and 55 minutes in the summer. Dates and weather conditions according to a meteorological website (Foreca, 2015–2016) of the video-recording days of John can be found in Appendix 2. Researcher observed John's video recordings for each season using the anecdotal recording method because it provided meaningful and detailed descriptive narrative recordings of behaviour of the child (Beaty, 1986). By systematic observation, the cut point for SA and PPA had been studied. Thus, at this phase, the researcher no longer had to make decisions about the cut points but was able to focus on those physical environmental factors related to John's activity change so that this cut point was exceeded. First, the researcher observed the first 15 minutes of John's video from autumn,

paused the video and documented on the form the physical environmental factors as well as a short narrative of the situation. After observing and documenting the first 15 minutes, the researcher observed the next 15 minutes, paused the video, and documented the factors. The same procedure was performed for minutes 31–45 and 46–60 and for each season's video. The written anecdotes totalled seven pages.

Phase 4: Analysis of textual case study data

The anecdotal data were saved in electronic form as a Word table for analysis (Appendix 2). In the analysis, the recorded physical environmental factors related to John's activity change from SA to PAA were compared with each other to classify them. The analysis showed that the physical environmental factors could be classified into three different types of factors: free spaces, natural material, and man-made objects. During the end of autumn's free outdoor playtime (between minutes 46–60), one of the ECE educators unexpectedly started instructing a game in which John participated. The physical environmental factors that occurred during this period were not taken into account because the activity was not free to play. Likewise, during the end of spring's free playtime (between minutes 46–60), surprisingly, one of the ECE educators ended the outdoor session and asked the children to collect the equipment from the yard and take it into the storage unit. The physical environmental factors that occurred at this stage of the observation were not considered in the results. To clarify the connection between the results of the anecdotal data analysis and their interpretation for a reader, we have combined their reporting thereinafter. This is the recommended reporting style for case studies (Doumont, 2010).

Ethical issues

From a research ethics perspective, it is noteworthy, that photographs have been used in this study to help illustrate a child's movement. The photographs have been carefully selected, kept to a minimum, and processed to ensure the anonymity of the subjects. Their use in the article publication had obtained permission from the parents of individual children. All procedures performed in the study were accepted by the Ethics Committee of the University of Jyväskylä. This study was conducted according to the ethical principles of research with human participants and ethical review in the human sciences in Finland (Finnish National Board on Research Integrity, 2019) and the European Union's General Data Protection Regulation (2016/679) (GDPR). It would have been possible for the parents / guardians of the children or the children themselves to suspend their participation in the study at any stage. All research material collected from them would have been deleted. However, there were no suspensions.

Results and discussion

Quantitative systematic observation of the entire video material showed the whole sample (12 children) spent an average of 25% of the time in SA and approximately 75% of the time in PAA during a 60-minute free outdoor playtime in each season. The corresponding percentages of John were approximately 32% for SA and approximately 68% for PAA. In alternative terms, during a 60-minute outdoor playtime, the whole sample spent an average of 15 minutes in SA (lying, sitting or standing without any observable gross motor movement) and an average of 45 minutes in PAA (walking, running, light-to-vigorous activities and games or riding a swing). For John the corresponding percentages were approximately 20 minutes for SA and approximately 40 minutes for PAA.

Although provision of opportunities to play in outdoor environments has been indicated as a significant environmental correlate of children's physical activity in ECE (Tonge et al., 2016), the results of this and previous studies (Truelove et al., 2018) showed that children still use a significant proportion of outdoor playtime for SA. According to Truelove et al.'s review (2018), the percentages of time spent in sedentary pursuits during childcare outdoor play sessions ranged from 23–63%. Consequently, the percentages of outdoor playtime spent in SA in this study would appear to be at the lower end (25–27%) of the range of previous studies (Truelove et al., 2018). In this study, in which children were observed using a systematic continuous observation method, the average percentages of time spent in PAA ranged from 73% to 75%, which were higher than the percentage range (33–55%) found in Truelove et al.'s (2018) results obtained from studies that measured children's activity with accelerometers. However, in the previous studies, in which observational methods were used as a measurement tool, children's average percentages of time spent in moderate-to-vigorous physical activity during outdoor playtime ranged from 2% to 54%. In turn, we found in our previous study that children's average percentage of time spent in moderate-to-vigorous activities and games during a 60-minute free outdoor playtime varied between 3–8% (Iivonen et al., 2019). Considerable variability in the research results of different studies is due to many reasons. One of most significant reasons is the variability in research designs and in the methods used to measure SA and PAA among children (e.g., surveys, observation, accelerometers, and pedometers) (Loprinzi & Cardinal, 2011; Trost, 2007).

The results of the whole sample also showed there was no large seasonal variation in SA and PAA: the average percentages of time spent in SA and PAA ranged between seasons from 25% to 27% and 75% to 78%, respectively. However, we found in our previous study, using the same data, that individual children showed significant seasonal variation

in percentages of time spent in different types of physical and sedentary activities during free outdoor playtime (Iivonen et al., 2019).

Figure 3 shows, by season, the percentages of 60-minute free outdoor playtime spent in SA and PAA by the whole sample (12 children) and by John. John's results revealed seasonal variation; his percentages of time spent in SA ranged from 22% (summer) to 49% (autumn), further indicating that his percentage of time spent in PAA during outdoor play was highest in the summer and lowest in the autumn.

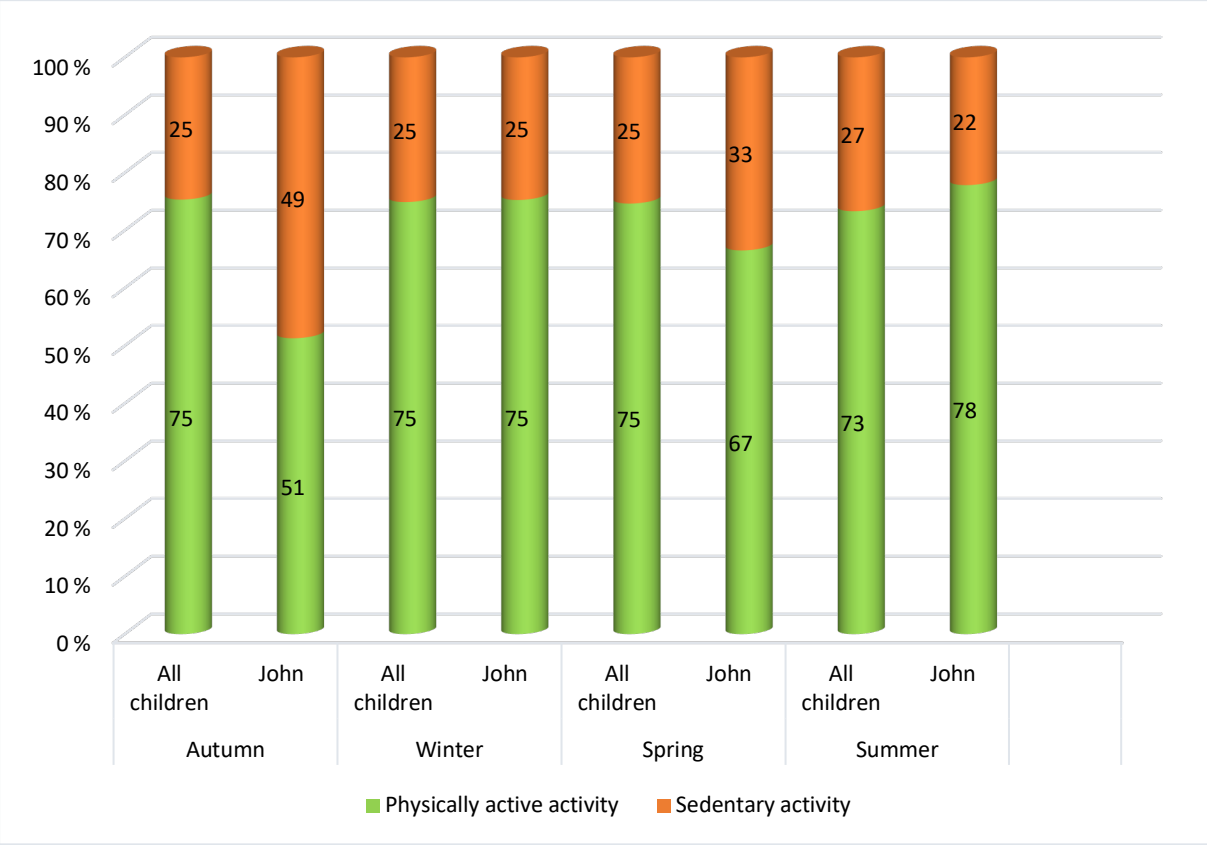

FIGURE 3 The average percentages of 60-minute free outdoor playtime in four seasons spent in sedentary activity and physically active activity by the whole sample (12 children) and by John

What makes John move?

Next, the results from the qualitative observation of John and the physical environmental factors related to his activity change from SA to PAA. The kind of activity recorded as SA and the kind of activity recorded as PAA are defined in Appendix 1. The factor was recorded if the child either manipulated the factor in different parts of the body using multiple motor skills (e.g., carried, waved, or dug) or if the child's actions clearly showed that gross-motor movement was directed towards that factor or if the child was simply

moving (e.g., walking or running) along a free space from one place to another. In the following sections, we have added photographs to clarify to the reader what the movement of the child was like.

The analysis of the observation (Appendix 2) showed there was a total of 71 occurrences of physical environmental factors in all seasons related to John's activity change from SA to PAA. The factors were classified into three different types: man-made objects, which occurred 28 times (39%); natural materials, which occurred 25 times (35%); and free spaces in the yard, with 18 occurrences (26%). The aforementioned factors by season are summarized in Table 1.

TABLE 1 Observed physical environmental factors in four seasons during 60-minute free outdoor playtime in the ECE unit yard relating to John's activity change from sedentary activity to physically active activity

AUTUMN	*WINTER*	*SPRING*	*SUMMER*
Free space (x 3)	Free space (x 3)	Free space (x 4)	Free space (x 8)
Wet sand (x 3)	Loose snow (x 4)	Wet sand (x 3)	Dry/hard sandy soil
Flowing water	Small snow pile	Rake (x 2)	Sand
Water	Big snow pile (x 6)		Lawn
Bucket (x 2)	Adult-sized shovel		Stick
Furniture (table, benches)	Bump		Dandelion
	Slide and stairs*		Stone
Rake (x 2)	Shovel (x 2)		Bucket (x 2)
Shovel (x 2)	Low table		Rake
Ice cube mould			Rocking horse
			Jump rope (x 3)
			Child's own cap
			Seesaw
			Kick scooter
			Fence
			Swing

Note: To make it easier to distinguish the three different types of factors, they are highlighted with different colours; free spaces in the yard in orange, natural material in green and man-made objects in blue. *These factors are shown in Figure 1 (a. and b).

In the autumn, water can make the physical environment attractive

The amount of SA for John was higher and the amount of PAA was lower in the autumn than in the other seasons. John spent nearly half (49% or approximately 29 min./60 min.) of the free outdoor playtime doing SA. The total number of physical environmental factors that were observed as relating to John's activity change from SA to PAA was 16. On the

day of the autumn videoing, the weather was rainy and cool, and the air humidity was very high at about 95%, which may have contributed to John's low level of physical activity. Studies have shown that cool and rainy weather may have a detrimental effect on children's physical activity (Carson & Spence, 2010). In contrast, rainwater in its various states (e.g., flowing from gutters, forming ponds or absorbing into the sand) may serve as a physically activating stimulus, which our findings may also suggest (Appendix 2). For example, water as an irregular natural material can stimulate children's imaginations and creativity (Bento & Dias, 2017) and thus inspire the movement of water in containers from one place to another (Figure 4).

FIGURE 4 Movement of water in a container from one place to another

In autumn, wet sand in the sandbox was observed three times relating to John's activity change from SA to PAA (Figure 5). Earlier studies have shown conflicting results on the association of a sandbox or sand play with children's physical activity levels. Gubbels et al. (2012) and Soini (2015) suggest negative association, while Ng et al. (2020) suggest positive association. In observing John, the situation appeared interesting. Because the sand was wet due to rainy weather, it was very malleable and heavier to manipulate, allowing him to use more physical force than if the sand had been dry. In three of the four PAA situations where wet sand was observed, John manipulated it with his whole body. A contributing factor to such activity being possible may have been appropriate clothing (Bento & Dias, 2017). John's clothing was waterproof throughout. For example, the trousers were attached to rubber boots and the rubber gloves were visibly well-fitting and attached to the sleeves, keeping them snugly on his hands. Studies have shown that clothing suitable for a physical activity environment increases the motor skills required for a child to move (Iivonen & Sääkslahti, 2013).

FIGURE 5 Manipulating sand

In the winter, snow piles tempt physically vigorous play

In winter, John spent approximately 25% (approximately 15 min.) of time doing SA and approximately 75% (approximately 45 min.) doing PAA during the 60-minute outdoor playtime. The total number of physical environmental factors observed and related to John's activity change from SA to PAA was 20. It was noteworthy that seven (35%) of them were snow piles. John moved in a snow pile and moved snow with different parts of the body. For example, during wrestling, struggling, jumping off a pile and roaring in the snow, the intensity of physical activity occasionally increased to moderate or vigorous (Figure 6). While some adults may be concerned that children's wrestling and other forms of rough-and-tumble play indicate real fighting or aggression, research supports their admission. It has been suggested that rough-and-tumble play develops physical, social, emotional and cognitive behaviours. This helps children learn self-control, compassion, boundaries and their own abilities compared to those of other children (Flanders et al., 2010). Rough-and-tumble play may also increase the intensity of physical activity (Pellegrini & Smith, 1998).

FIGURE 6 Struggling in a snow pile

On the day of the winter videoing, there was a lot of snow in the yard, with plenty of non-ploughed areas and a few piles of snow. The biggest snow pile was centrally located in the

yard. The findings of this study may suggest that such an environment with snow piles and the availability of equipment, such as shovels (Figure 1 e.) and bumps, suitable for snow activities may physically activate a child in winter (Figure 7). For example, shovelling has been shown to be an activity that more than quadruples children's physical energy expenditure compared to their resting level (Butte et al., 2018). Previous Norwegian studies have shown that moving in the snow can have additional benefits. Bjørgen's (2015) study in one ECE unit indicated that during outdoor play, children's well-being, involvement and intensity of physical activity were at their highest during snow activity situations. Another longitudinal Norwegian study showed that versatile physical activity in the wintery forest had beneficial effects on children's physical and motor performance (Fjørtoft, 2001).

FIGURE 7 Shoveling snow

In the spring, changes in activity occur less frequently

In the spring, John spent approximately 33% of the time in SA and approximately 67% of the time (approximately 40 min.) in PAA. The amount of PAA was lower than in the winter or in the summer. Again, as was the case in autumn, on the day of spring videoing, the weather was rainy and cool, which could adversely affect John's physical activity (Carson & Spence, 2010). The number of physical environmental factors that were observed and related to John's activity change from SA to PAA was nine, which was lower compared to the other seasons. This meant that changes in John's activity from SA to PAA occurred less frequently and that he enjoyed the same activity for longer periods of time than in those play sessions when physical environmental factors associated with changes in activity level were more frequent and activity variability was greater. Detailed results (Appendix 2) revealed that John spent periods of several minutes in the

sandbox either sitting (or standing) still or manipulating sand (digging or striking with a rake) at light physical activity intensity. It might have been that humid and rainy weather changed tactile qualities of the sand so that playing with sand interested John (Jarrett et al., 2010).

The spring observation results also showed that John left the sandbox a few times and moved in the free spaces of the yard. There were quite a lot of free spaces in the yard (Figure 1 a.), which allowed John freedom to move here and there, and his PAA might have lasted longer than it would have if the yard had been cramped. Indeed, previous studies have shown that larger sized play areas are a significant correlate of physical activity (Tonge et al., 2016) and development of gross motor skills (Sääkslahti et al., 2018). According to the national survey (Kämppi et al., 2020), two out of three Finnish ECE units (total number of units = 150) assessed the size and functionality of their yard as at least good. However, Sääkslahti et al.'s (2018) study indicated considerable variation in the size of the yards among the units. This places the children in different ECE units in an unequal position in terms of the conditions that allowed physical activity. The aspects of environmental design and size are issues of ongoing research (Gubbels et al., 2018; Ng et al., 2020; Niemistö et al., 2019) and provide evidence of the significance of appropriately designed ECE environments that offer opportunities for physically active play in outdoor spaces (Tonge et al., 2016).

Summer makes John move

In the summer, John spent approximately 22% of the time in SA and approximately 78% (approximately 47 min.) of time doing PAA during the 60-minute outdoor playtime. The percentage of PAA was higher than in other seasons. This result is consistent with previous studies suggesting that children's physical activity is highest during the summer months (Carson & Spence, 2010). However, more research is needed because there is not a full understanding of how physical activity and sedentary behaviours of children living in different climatic and geographical conditions vary by seasons (Harrison et al., 2017). So far, in some countries, the most important climatic factors that seem to increase children's physical activity levels are lower precipitation, lower wind speed, more hours of daylight and a temperature range between 0–20°C (Harrison et al., 2017). Based on this information, ideal weather conditions for physical activity prevailed on the day John's summer videoing took place, which could be reflected in his results (Appendix 2). However, in a previous Finnish study, significant seasonal variation was not found in young children's physical activity levels, suggesting that season is only one factor that may affect activity and its role is not unambiguous (Soini, 2015). In any case, attention should be paid to encouraging children towards physically active outdoor play in all seasons

regardless of climatic factors (Finnish recommendations for physical activity in early childhood, 2016).

Twenty-six physical environmental factors were observed relating to John's activity change from SA to PAA in the summer (Table 2). The amount and variability of factors were higher than any other seasons. A total of 12 man-made objects (46%) were observed, of which the jump rope occurred three times (Figure 8) and the bucket occurred twice. The occurrences of six different natural materials (23%) and a total of eight free spaces (31%) in the yard were observed. This result of increased PAA by John, possibly explained by a higher number of physical environmental factors observed, is supported by previous studies suggesting that amount and variation in physical environmental factors, which create active opportunities in the ECE outdoor setting, appear to play a more influential role in children's PAA and SA levels than the duration of outdoor playtime per se (Hodges, et al.,, 2013; Tonge et al., 2016). In earlier studies, children engaged in higher levels of PAA when the ECE outdoor environment provided, for instance, more playground equipment, such as balls and wheeled toys (e.g., kick scooters); more natural material (e.g., grassy and wooded areas); and an larger playground area overall (Dankiw et al., 2020; Gubbels et al., 2012; Hodges et al., 2015; Tonge et al., 2016). Importantly, Gubbels et al.'s (2018) results showed that characteristics of individual children interacted highly with ECE outdoor physical environmental factors, purporting that different children needed different opportunities to be active and that the current arrangement of the outdoor environment of an ECE unit was more suitable for some children than for others. Their findings support the importance of our findings.

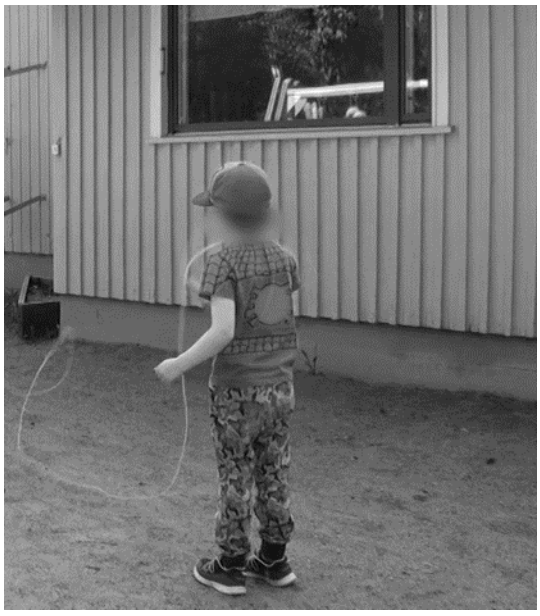

FIGURE 8 Jump rope manipulation

Another significant result observed in the summer was that John rode a swing continuously for about 12 minutes (Figure 9). Potential reasons explaining the occurrence of riding a swing in the summer may be either that the swing equipment was not available at other times, as was the case in the winter, or the swing was wet, making it less tempting to sit on, as was the case in the autumn and spring. The relatively long duration of riding a swing by John could reflect his involvement in this activity at that moment. Involvement describes the quality of a person's activity, characterized by persistence, a high level of motivation and a high degree of satisfaction (Laevers, 1993). According to Csikszentmihalyi et al. (2005), a highly involved individual is in a state of flow, which in turn is characterized by matching the environmental challenges with equal levels of skill, merging action and awareness, a sense of control and a distortion of temporal perception. So, it may well have been that, at that moment, riding a swing evoked some of the aforementioned experiences in John, increasing his involvement, which in turn was reflected in our results as a long duration of riding a swing. Previous studies have shown that children expressed experiences of joy and well-being in activities that included speed, fast movement and an experience of being in the air (Bjørgen, 2015; Ward, 2018). Riding a swing has other beneficial effects on children's development. The swinging movement stimulates perceptual motor integration skills, which are a prerequisite for executive functioning and intellectual learning (Rosenbaum et al., 2001). Therefore, the swinging movement has been used as a neurological rehabilitation method (Wuang et al., 2009).

FIGURE 9 Riding a swing

Previous large-sample studies using motion sensors on children's PAA and SA in ECE settings have found swing equipment limits children's physical activity levels (Cardon et al., 2008; Gubbels et al., 2012). In this study, which used direct continuous observation of an individual child, the experienced investigator was able to observe that while increasing

and decreasing speed of the swing, holding the swing ropes and controlling the movement of body, the child's core and limb muscles worked, and he used perceptual motor skills and dynamic balance skills all the time. Such activity has not been reported in previous studies (Cardon et al., 2008; Gao et al., 2018; Gubbels et al., 2012). Differences in research results may be largely due to the difference in measurement method (motion sensors vs. direct observation) and study design (e.g., large sample vs. individual observation). However, children's riding a swing in ECE outdoor settings has been relatively little studied, especially from the perspective of promoting physical activity (Iivonen et al., 2019). This is troublesome because swings are the most common fixed equipment in ECE outdoor environments (Kämppi et al., 2020) and because riding a swing has been considered by children as the most popular play environment in ECE (Holmes & Procaccino, 2009; Ward, 2018).

Summary and implications

The purpose of this longitudinal mixed-method case study was to observe one physically sedentary child's free outdoor play in the yard of an ECE unit in four seasons and to determine the physical environmental factors related to his activity change from sedentary activity to physically active activity. We first identified the individual child in the group of children of an ECE unit who engaged, on average, the highest percentage of free outdoor playtime in sedentary activity. He became the participant-child "John". The results showed he spent an average of 25% of the time doing sedentary activity and 75% of the time doing physically active activity during a 60-minute free outdoor play session in each season. Seasonal results showed that John's percentage of time spent in sedentary activity raged from 22% (summer) to 49% (autumn) between seasons. It is important to note that this study focused only on the analysis of physical environmental factors in ECE outdoor environment and their role in excessively sedentary child's activity. Many other socioecological factors may have affected the results, but they were not controlled or examined in this study. For example, the attitudes and actions of early childhood educators as well as children's personal characteristics are known to be related to children's activity (Mehtälä et al., 2014; Tonge et al., 2016).

A key finding was that there was a total of 71 occurrences of physical environmental factors in the outdoor play related to the child's activity change from sedentary to physically active in various seasons. Of these factors, man-made objects, such as portable and fixed play equipment occurred 28 times (39%); natural materials, such as water, sand and snow occurred 25 times (35%); and free spaces in the yard occurred 18 times (26%). The highest number of physical environmental factors was observed in the summer (28

occurrences; 39%) and the fewest in the spring (9 occurrences; 13%). Many of the observed factors in this study were similar to earlier studies, suggesting that children engage in less sedentary behaviour and more physically active behaviour when ECE outdoor environment had more free space, provided more playground equipment, and provided natural material (Dankiw et al., 2020; Gubbels et al., 2018; Hodges et al., 2015; Tonge et al., 2016). The results suggest that in the summer season the ECE outdoor play environment offers the most physical activity opportunities.

Another finding of this study, not reported in previous studies, was that seasonal changes and climatic conditions may change the outdoor play environment to physically activating. Humid weather, as it is often in autumn and spring, can make sand in the sandbox malleable, allowing a child to manipulate it in a variety of ways. In winter, piles of snow can entice a child to move in a variety of physically intense ways, and unevenly distributed snow in the yard provides challenging surfaces that can develop fundamental locomotor skills (Sääkslahti et al., 2018). An important finding was that the child rode a swing 20% of the outdoor play time in the summer. The researcher was able to observe that to control the movement of the swing and his own body on the swing, the child had to use his perceptual and motor skills. This kind of physical activity has not been reported in previous studies (Gao et al., 2018; Truelove et al., 2018). Both sandboxes and swing equipment are the most common outdoor fixed environments for ECE units (Kämppi et al., 2020), and both fit well with many of the goals of ECE (Finnish National Agency for Education, 2018). From the physically activating point of view, they need to be studied more (Ng et al., 2020).

In the future, analysing how the size of the sandbox, the composition of sand and the equipment used change children's physical and motor activity would be important. The effects of different swings and styles of riding a wing on the intensity of physical activity are also worth of studying. Given that the pedagogical practices of early childhood educators influence children's play behavior (Kyhälä et al., 2012), further research should be also carried out to examine the possibilities for early childhood educators to add elements and modify the ECE outdoor environment to attract all children to move.

Strengths and Limitations

This study had several limitations. First, the case study data was collected only on one day of each season and therefore the generalizability of the results remains weak. Because children's physical activity varies from day to day (Bailey et al., 1995; Fisher et al., 2005; Van Cauwenberghe et al., 2012), it would have been more appropriate to have more data

collection days in every season. Now the results may reflect the child's state of alertness on the day the videoing took place. It could have been that the results of the case study would have been different if the data had been collected on another day. Second, socioecological factors such as weather conditions, educator's and other children's behaviour, as well as individual characteristics of the child may have affected the results (Tonge et al., 2018), but they were not controlled in this study. Third, this study analysed the physical environmental factors of the yard of only one ECE unit. The physical environmental factors and their relationship to the change in the child's activity could have been different if the data had been collected in the yard of another or several different ECE units.

A longitudinal study covering all four seasons as well as the use of video recording as a data collection method were the strengths of this study. Other strengths of this study were that it combined systematic observation, quantitative and qualitative data analysis. To understand the activity behaviour of young children, longitudinal and intensive data collection methods as well as systematic observation have been found to be valuable (Trost, 2007). And finally, this study increased our understanding of what physical environmental factors at different seasons may enhance active play for a child who enjoys, on average, more sedentary activities than other children.

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Appendix 1 Systematic observation categories and their interobserver reliability

CATEGORY NAME	*ACTIVITY CODED IN THIS CATEGORY*	*INTEROBSERVER RELIABILITY*
Physically active activity (PAA)		**Percentage (%) of agreement**
Walking	Walking continuously for three seconds or more	87%
Running	Running continuously for three seconds or more	94%
Light activities and games	Doing light activity intensity	97%
	non-locomotor movements (axial movements, such as bending, stretching, twisting, turning, reaching, lifting and falling)	
	upright or inverted supports or balancing (individual stunts, partner stunts, balancing on a narrow support base, headstand, handstand, body rolling and somersault)	
	manipulative movements (throwing, catching, ball bouncing, rolling, kicking and trapping/collecting)	
	touching, riding or pushing wheel toys that are not fixed equipment (trucks, scooters, rickshaws, tricycles and wagons)	
Moderate-to-vigorous activities and games	Engaging in moderate-to-vigorous activity intensity	99%
	locomotor movements (leaping, sliding, galloping, jumping, hopping and skipping)	
	manipulative movements (throwing, catching, ball bouncing, rolling, kicking and trapping/collecting)	
	touching, riding or pushing wheel toys that are not fixed equipment (trucks, scooters, rickshaws, tricycles and wagons)	
Swing riding	Riding a swing continuously for three seconds or more	100%
Sedentary activity (SA)		
Lying down	Lying down with no movement	100%
Sitting	Sitting still with little to no limb movement	91%
Standing	Standing still with little to no limb movement	96%

Appendix 2 Analysis of the observation of the physical environmental factors and situations in which the activity of John changed from sedentary activity to physically active activity

	SEASON			
	AUTUMN	*WINTER*	*SPRING*	*SUMMER*
Minutes	Date: 22.10.2015 Weather: +7°C, cloudy, occasional rain, wind 3m/s	Date: 22.2.2016 Weather: -4°C, snow, wind 17m/s	Date: 19.4.2016 Weather: +2,9°C, cloudy, rain, wind 2m/s	Date: 24.5.2016 Weather: +20°C, dry, clear, wind 1m/s
0–15 min.	• Flowing water from the gutter fills a bucket that the child carries to move the water to another place • Free space where the child moves on foot or running to collect a bucket from the storage unit[1]	• Big (appr. 1.5 m high) snow pile that the child digs with an adult-sized shovel • Free space[2] where the child walks along unploughed ground (for appr. 20 m) to the storage, takes a pump and pushes loose snow while walking, sometimes taking running sprints • Low table covered with snow that the child goes to his stomach until he begins to play in another small snow pile (snow is light, not wet) and then	• Free space (appr. 10 m) in which the child walks to the storage[1] and takes a rake and again walks across the free space to the sandbox • Wet sand in the sandbox that the child strikes and digs with hands and a rake	• Dry and hard sandy soil that the child beats with a bucket • Hard pieces of soil that child carries while running across free space[2] (appr. 20 m) • Dry sand in the sandbox that the child beats into a bucket with a rake • Free space[2] (appr. 10 m) where the child walks • Lawn next to the fence on the other side of the yard where the child walks exploring the grass • Free space around the swing (about 20 m in diameter) where the child runs

		shapes it with his hands using his whole body • Free space[2] where the child walks along ploughed and unploughed ground		• Rocking horse on which the child sits, holding the handles, and swings vigorously back and forth • Jump rope which the child swings with hands at the same time waving his whole body • Free space[2] where the child runs • Dry and hard sandy soil (same as in the beginning of session) that the child beats with a bucket and hands
16–30 min.	• Free space[2] where the child runs while simultaneously skipping, crossing or dodging furniture (table, benches) • Rake that the child picks up from the storage[1], moves to the sandbox and pummels holes in wet sand with the rake	• Loose snow in a snow pile in which the child makes lumps and throws loose snow • Free space[2] (both ploughed and snow-covered area) where the child walks • Stairs, tower and slide[3] on which the child climbs up either the stairs or the slide and slides down the slide and takes running sprints on the ground	• Free space around the playhouse[4] where the child moves in different ways and runs	• Child's own cap that flies to the ground, which the child collects and waves • Seesaw where the child swings up and down in a sitting position holding the handles • Free space[2] where the child walks • Kick scooter that the child holds with both hands and carries back and forth • Free space[2] where the child walks

				• Jump rope that the child holds with both hands and swings back and forth using whole body • Free space[2] where the child runs (appr. 30 m) • Stick that the child grabs and swings while running back and forth • Dandelion that the child grabs and continues to run
31–45 min.	• Flowing water from the gutter from which the child fills a bucket and carries (appr. 10 m) across free space to the sandbox • The sandbox where the child pokes holes in wet sand with a rake and uses a shovel to fill the bucket with wet sand • A shovel the child uses to dig wet sand out of the bucket back into the sandbox	• Big (appr. 1.5 m high) snow pile (the same as in the beginning of session) that the child manipulates vigorously • Same big snow pile where the child plays rough and tumble • Same big snow pile where the child runs and jumps from the top of the pile to the front and down • Shovel that the child takes and walks to the top of same big snow pile and begins to shape the snow with a shovel	• Wet sand in the sandbox that the child digs in a sitting or kneeling position using both hands and whole body • Free space[2] where the child runs	• Free space[2] where the child walks • Fence around the swings that the child holds with both hands and jumps up and down vigorously • Jump rope that the child holds with one hand and moves while standing, jumping and moving back and forth • Swing on which the child rides in sitting position (appr. 12 min.)

46–60 min.	• The sandbox where there is an ice cube mould the child fills with wet sand and then pummels the "ice cubes" out of the mould to the edge of the sandbox using a shovel • Free space with furniture, natural material, building and scaffolding where the child runs (sometimes stops) when an educator suddenly starts a game of tag	• Same big snow pile that the child shapes with shovel • Loose snow in the yard that the child shapes with his hands	• Wet sand in the sandbox that the child digs with a rake in a sitting or standing position using both hands and whole body • Free space where the child walks. Suddenly, an educator finishes the outdoor play session and asks children to collect all equipment in the yard and take it to the storage. The child moves and collects equipment (a shovel, a toy car, a small motorcycle, etc.) and carries these to the storage on the other side of the yard	• Free space[2] where the child walks • Stone[5] on which the child climbs

Note: [1] The storage unit is shown in Figure 1 (d.), [2] Some of the free spaces in the yard are shown in Figure 1 (a., b., c., and g.), [3]Stairs, tower and slide are shown in Figure 1 (b.), [4]Free space around the playhouse is shown in Figure 1 (c.), [5]The stone is shown Figure 1 (g.)