




# Children's time use and moderate-to-vigorous physical activity in early childhood education and care in Finland



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**Background:** The role of early childhood education and care (ECEC) is crucial in the implementation of the physical activity recommendations during long ECEC days. Young children should engage in 180 minutes of physical activity spread throughout the day, including 60 minutes of moderate-to-vigorous physical activity (MVPA). To attain the goal more information is needed on children's time use and physical activity (PA) in children's activities.

**Aim:** The purposes of this quantitative observational study were twofold: (1) to examine children's time use and (2) to describe which children's activities best generate physical activity, specifically MVPA, in ECEC.

**Setting:** Altogether, 2879 Finnish children, aged from 1- to 6-years, participated in this study.

**Methods:** The data of 57 881 observations were analysed using cross-tabulation and a z-test.

**Results:** *Daily routines* (e.g. eating, dressing, napping and transition), *task or seatwork* and *material play* accounted for almost 70% of children's sedentary behaviour and less than 10% of MVPA. The best MVPA generators were *physical activities* (that generated 57.4% of all MVPA in boys vs. 62.8% in girls, respectively), *rule play* (11% in boys vs. 6.7% in girls) and *role play* (10.1% in boys vs. 9.9% in girls) as well as *action not allowed* (3.3% in boys vs. 1.2% in girls).

**Conclusions:** Educators should integrate *physical activities*, *rule play* and *role play* more in ECEC day to support the realisation of the recommendations.

**Keywords:** early childhood; physical activity; efficacy; children's activities; moderate-to-vigorous physical activity.

## Introduction

The purpose of this study is to inspect children's time use and physical activity (PA) in early childhood education and care (ECEC). The PA guidelines for young children (WHO 2019) recommend 180 minutes per day in a variety of PA at any intensity level, including activities during which the child gets hot and breathless, for example, brisk walking, cycling, running, playing ball games, dancing etc., that is moderate-to-vigorous physical activity (MVPA), and these activities should be spread throughout the day. Children over 3 years should engage in MVPA for at least 60 minutes per day (WHO). In Finland, the recommendations suggest versatile activities of at least 1 h of MVPA, 2 h of light physical activity (LPA) and outdoor activities daily for children under 8 years. Light physical activity refers to activities that do not result in the child getting hot or short of breath. Despite research and the current recommendations, recent reviews have reported that preschool children spend most of their waking time sedentary or in very light physical activity (VLPA) (Lindsay et al. 2017; Verloigne et al. 2016). However, there is a lack of empirical research on children's time use and PA in different activities in ECEC. This information is essential when targeting young children's compliance with the PA recommendations.

Physical activity is important for children in many ways. Physical activity patterns and fitness start to develop in the early years and the stability of these patterns is moderate or high along the life course (Caldwell et al. 2016; Telama et al. 2014). In addition, PA is associated with young children's motor skills, physical and psychosocial health, well-being (Carson et al. 2017; Poitras et al. 2016; Timmons et al. 2012), self-regulation (Becker et al. 2014) and academic skills (Diamond 2015; Fedewa & Ahn 2011; Krafft et al. 2014; Mavilidi et al. 2018; Pesce et al. 2016). Very light physical activity that can be defined as any waking behaviour associated with energy expenditure  $\leq 1.5$  metabolic equivalent (MET) and a sitting or reclining posture (Biddle & Asare 2011; Sedentary Behaviour Research Network 2012) has been negatively associated with the same components.

Typical of young children's PA are short bursts of MVPA followed by brief but variable intervals of lower intensity activities or resting (Bailey et al. 1995; Dwyer, Baur & Hardy 2009). As a result of these bursts, most lasting less than 5 minutes in 3- to 5-year-old children, Ruiz et al. (2018) reported that it takes more than 11 h to get enough MVPA per day. The Finnish guidelines, intended also for ECEC teachers, recommend that sedentary periods should not last longer than 1 h, and all inactive periods – even shorter ones – should include breaks (Ministry of Education and Culture 2016). Concurrently, the average length of a child's day in ECEC is 7 h in the Organisation for Economic Co-operation and Development countries, but even 10-h days are possible (OECD 2018). Thus, the role of ECEC is crucial in the implementation of the recommendations during ECEC days (Bower et al. 2008; Van Cauwenberghe et al. 2012; Ward 2010).

### Children's activities in early childhood education and care

The term ECEC refers here to the education and care of children who take part in early education in Finland. It is organised in ECEC centres or in family day care that involves a care provider (childminder) looking after the children in his or her own home (< 6 years old) and in compulsory pre-primary education (6-year-olds), mostly organised in ECEC centres (84% in the year 2018). A minority of pre-primary education in Finland is organised at schools (OSF 2019). Concurrently, the term young children refers here to children aged from 1- to 6-years.

A significant proportion of the variation in young children's PA level has been attributed to the preschool or ECEC environment (Bower et al. 2008; Pate et al. 2004; Tonge 2016). According to the review of Coe (2018), outdoor play, motor skill development and competence, the preschool environment and the influence of caregivers have been examined and associated with children's PA levels in preschool settings. We propose that in addition to these factors, children's own behaviours during all basic settings in ECEC need to be explored regarding children's PA and sedentary behaviour. Such research is scarce.

Early, Iruka and Ritchie (2010) described that preschool classrooms can be split into three basic settings: free choice, teacher-assigned and meals or routines. The term *general activities* refers here to the combination of preschool classrooms and basic settings, as typically scheduled and organised in Finland including instruction or direct education inside, scaffolded play inside, free play inside, outside activity, basic care, snacks and meals and transitions. As the Finnish ECEC is based on play, children have free play inside and outside twice a day, which makes the 'schedule' different from many other countries (Finnish National Agency for Education 2016).

In this study, we investigate *children's activities* that vary during general activities, as Reunamo (2007:35) described.

*Children's activity* (or *action*) is defined here as the activity the child really does (can be observed to do). Children's activities are mutually exclusive and children can engage in them during all *general activities*. For example, in the context of direct education (or any other activity in general activities), children can be observed reading; doing task or seatwork; running, walking or other physical activities; action with no focus; material play; rule play; role play; hanging about with others and in action not allowed.

Children's activities in Finnish ECEC have been studied earlier by Reunamo et al. (2014a, 2014b). Reunamo et al. (2014a) explored children's time use in children's activities as well as the proportion of MVPA in free play. They reported that *playing with toys and materials* was children's main activity in free play outdoors and indoors (36.4% of children's time). However, it involved only 5.2% of MVPA. The highest density of MVPA was found in *rule play* during free play outdoors. During free play inside, the highest density of MVPA was found in *action not allowed* in Reunamo et al. (2014a). However, they explored children's activities only during free play indoors and outdoors. Thus, in this study we focus on children's activities in all general activities. In the study of Reunamo et al. (2014a), children were observed only in the mornings, and *physical activities* were not distinguished from the other children's activities. Instead, children's PA intensity level was measured in all children's activities. In the present study, PA was measured in *physical activities* and in other children's activities.

Educationally oriented studies, implemented in other countries (e.g. Early et al. 2010; Vitiello et al. 2012), have mostly targeted time use in different basic settings, specifically in teacher-assigned activity settings. Brown et al. (2009) studied young children's PA levels, the topography of their PA and the indoor and outdoor social and non-social context of the activity in preschool. They found that sitting, squatting, lying down, standing and walking are typical behaviours during young children's ECE days, and indoor activity contexts, such as snacks, naptime and transitions, were often exhibited throughout preschool days. They also found that academic activities do not generate MVPA (Brown et al. 2006, 2009). Still, little is known about what children really do in ECEC and how active they are in different activities.

Boys and girls have been reported to participate in different kinds of activities that generate MVPA differently. For example, from age three, girls engage more in work, whereas boys spend more time in play. Boys' play includes weapons and vehicles that generate MVPA, whilst girls engage in more grooming and fine motor activities (DiPietro 1981; McIntyre & Edwards 2009; Pellegrini & Smith 1998; Reunamo et al. 2014a; Todd et al. 2017). In addition, earlier reviews have indicated boys to be more physically active in ECEC than girls, specifically in MVPA (Hinkley et al. 2008; Spittaels et al. 2012; Tonge, Jones & Okely 2016). However, further information is needed on how gender differences appear in

children's activities and their PA levels in ECEC. Accordingly, this research aims to explore differences in boys' and girls' time use and PA in children's activities in Finland. The research questions are:

1. What percentage of time (%) do children spend in *children's activities* and what is the proportion (%) of VLPA, LPA and especially MVPA in these actions?
2. What differences are there between genders in the proportions (%) of time spent in *children's activities* and proportions (%) of PA intensity levels in these actions?

## Methods

### Observer training

The data were collected by observation. The observers were qualified ECEC teachers in the participating groups, and they had to attend four full-day training sessions in Autumn 2014. The training sessions included lectures, video observations of children's everyday situations and discussions about observation practices and categories. Between the training sessions, the teachers practised their observing skills in their own groups. The inter-rater reliability was checked during the observation training and after the observation. The reliability was good for both observation categories at the end of observation training, even though some videos had lower reliability, indicating that some situations were more difficult to classify than others.

Cohen's kappa was used in the paired reliability check for children's activities because of the nominal variable. The value of Cohen's kappa in the paired reliability check for children's activities' classification was 0.706 ( $p < 0.0005$ ), which is a sign of good reliability. In the paired reliability check for the PA intensity level (ordinal variable), the intra-class correlation coefficient was used. The value of the intra-class correlation coefficient (one-way random) was 0.744 ( $p < 0.0005$ ), which is a sign of good reliability.

### Data collection

Two randomly chosen teachers observed a group in each other's ECEC centre between January and June 2015. Children's names and corresponding research numbers were written on a separate list before the data collection. To get to know the names and numbers of the children that they were going to observe, observers could exchange their workplaces for 1 day prior to observation.

Every group of children was observed systematically for 7 days. The days of observation were randomly selected from all the weekdays between January 2015 and May 2015 excluding public holidays and skiing holiday. Only the observer knew the observation days in advance. To prevent systematic bias, the observer started each day with a different child on the list. If the child was missing, the next child on the list was observed and the missing child was included in the observation when he or she arrived. The observations were made between 08:00 and 12:00 for 6 days, and for 1 day between 12:00 and 16:00, in 5-minutes intervals. If the

schedule required it, the observations could be made, for example, between 09:00 and 13:00. Each observation took 1 minute and happened at the same time of the interval each time. The additional 4 minutes were reserved for coding and preparing for the next observation (e.g. finding the next child on the list).

The observers were instructed to use the mean activity to determine children's activities. If it was impossible to determine the action, it could be coded as *other action*. The coding was carried out only after the observations, and the observers did not look at the children when they did the coding. The observers could move around when needed, and they were told not to seek interaction or eye contact with the children, but if necessary, they could reply briefly to questions. They were also told that the observed child should not be aware of being observed. Altogether, approximately 49 observation periods were completed in 1 day, but the number of observations per child varied because some children were absent, and consequently, the group sizes could vary.

### Children's activities

The coding of children's activities is based on Reunamo's observation scale (Reunamo et al. 2014b). When classifying children's activities, the observers chose the *first possible* ongoing alternative starting from the top to the bottom. Only one activity could be chosen. If the child moved from one action to another, which could happen more than once during the observation period of 1 minute, the principal action was chosen from the list:

1. *Role play*, that is imaginary play (e.g. using a toy or having a role to play).
2. *Rule play* (e.g. ball games like football or soccer and dodgeball; chess; games with fixed rules such as tag and follow the leader; competitions with certain rules such as sport competitions like relay races).
3. *Material play*, that is playing or exploring with toys and materials (e.g. sitting at the sandbox making sand cakes, making paper airplanes, playing with cars or bricks).
4. *Physical activities* (e.g. running, swinging, dancing, jumping, climbing, exercising). As the name of an action, *physical activities* are different from the term PA.
5. *Reading* (i.e. the teacher reads or the children read to themselves).
6. *Task or seatwork* (e.g. homework, pen and paper exercise, dressing, nursery rhymes, refining a skill, work).
7. *No focus* or proper contact with others (e.g. walking around, no clear contact, searching or waiting).
8. *Hanging about* together with others (e.g. chatting and/or walking with others, chatting at the jungle gym).
9. *Action not allowed* (e.g. not following orders, teasing, disrupting others).
10. *Acting according to the routines*, which does not include behaviours 1–9, or shorter *routines* (e.g. child eats during meals or snack time, dresses at appropriate time, washes hands). If the child was sleeping, it was coded to *routines*. In the case of, for example, running during afternoon naps, it was marked in *physical activities*.

11. *Other action*, that is action that does not fit in other categories (e.g. confusion, a lot of changes, no structure, difficult to pinpoint).

### Physical Activity Intensity Level

Children's PA intensity level in each time interval was categorised into three levels. A corresponding three-level activity coding has been a common method for representing children's PA in previous research (e.g. Brown et al. 2009; Finn, Johannsen & Specker 2002; Pate et al. 2004). The observers were instructed to select the most prevalent one:

1. VLPA (e.g. lying, sitting, eating, reading and watching television).
2. LPA (e.g. walking, whole body movements).
3. MVPA (e.g. some running, physical exertion).

### Statistical analysis

In the analysis, the IBM Statistical Package for the Social Sciences (SPSS) for Windows version 25 (IBM Corporation, United States of America) was used. To analyse the relationship between nominal (children's activities and genders) and ordinal variables (PA intensity levels) in the data, cross-tabulation was chosen as the main method of analysis. The unit of analyses was observations, which allowed us to use all the data (Winsler & Carlton 2003) of 57 881 observations. To check the reliability of the observations, two independent observers observed the same children at the same time (only one observation of each paired observation was included in the data). Altogether, there were 620 paired observations. In the cross-tabulations, the statistical significances were calculated with the *z*-test. The level of statistical significance is 0.05.

### Participants

The participating children were aged 13–89 months (Mean [M] = 61.9 or 4.7 years, standard deviation [SD] = 20 or 1.7 years), with 1209 boys (42%), 1069 girls (37.1%) and 601 (20.9%) without gender reported. Children's ages fell into groups as follows: 25.2% were 13–47 months old (1–3 years), 31.9% were 48–71 months old (4–5 years) and 42.9% were 72–89 months old (6–7 years). We included all children with consent in the pre-primary group even though they had reached 7 years. (School start may be postponed for some children to ensure smooth transition from pre-primary to primary school). Group size varied from 4 to 33 children (M = 18.4, SD = 4.9). Because gender was not reported for every child, the percentages are slightly different (Table 1 and Table 3).

### Ethical considerations

This quantitative observational study was completed in southern Finland in 2015 as part of the orientation project – an ECEC research and development project. All 194 ECEC centres, teachers and nine childminders were from municipalities. The municipalities made the decision about

how widely they would cooperate in the research. Some municipalities provided all ECEC centres an opportunity to participate, whilst others offered the opportunity only to a random sample or a certain ECEC area. Only one group of children participated in each ECEC centre. Informed consent was obtained from all participating children ( $N = 2879$ ) and their guardians after the research was approved by the Education and Early Education Committee of the municipality. Observers were trained to consider children's integrity by respecting their autonomy and privacy and avoiding unnecessary harm during the observation training sessions (Tenk 2019). Identification data (full names, birthdays) were not collected and the children received a number that was used in data collection and analysis. If the participating children or their guardians did not want to participate, they could withdraw at any stage. We began to include approval for the project from the University of Helsinki Ethical Review Board in 2016.

## Results

### Whole Sample

Of all the observations, children spent around 57% in VLPA, 31% in LPA and 11% in MVPA. The MVPA percentage was 11.6% of all observations in the morning and 8.5% in the afternoon. The most common activity was *daily routines*, with one-third of all observations, but it did not prompt MVPA (Table 1). Only 1% of *routines* was MVPA (Table 2) and of all observed MVPA 3% occurred in *routines* (Table 1). However, although almost half of *routines* were sedentary by nature, it appeared to be a good source of LPA.

*Physical activities*, *material play* and *role play* took altogether as many children's time as *routines*, but especially *physical activities* and *role play* proved to be the best supporters of MVPA in the whole sample. Although children engaged frequently in *material play*, only 5% of *material play* was MVPA and of all observed MVPA only 5.2% occurred in *material play*. On the other hand, similar to *role play* and *physical*

**TABLE 1:** Children's time use and proportions of the physical activity intensity levels (of all observations in each intensity level) in children's activities ( $N = 57\ 881$ ).

Children's activities	Time use (%)	PA intensity levels		
		VLPA (%)	LPA (%)	MVPA (%)
-		57.4	31.4	11.2
Daily routines	32.9	44.4 <sub>a</sub>	22.2 <sub>b</sub>	3.0 <sub>c</sub>
Physical activities	10.8	0.8 <sub>a</sub>	11.9 <sub>b</sub>	59.7 <sub>c</sub>
Material play	10.7	10.1 <sub>a</sub>	13.7 <sub>b</sub>	5.2 <sub>c</sub>
Role play	10.3	6.3 <sub>a</sub>	17.8 <sub>b</sub>	10.0 <sub>c</sub>
Task or seatwork	10.1	14.2 <sub>a</sub>	5.6 <sub>b</sub>	1.4 <sub>c</sub>
No focus	8.1	7.0 <sub>a</sub>	11.7 <sub>b</sub>	3.4 <sub>c</sub>
Reading	4.6	7.2 <sub>a</sub>	1.1 <sub>b</sub>	0.3 <sub>c</sub>
Rule play	4.5	4.2 <sub>a</sub>	3.3 <sub>b</sub>	9.4 <sub>c</sub>
Hanging about	4.2	2.9 <sub>a</sub>	6.9 <sub>b</sub>	3.6 <sub>c</sub>
Other action	2.3	1.8 <sub>a</sub>	3.5 <sub>b</sub>	1.7 <sub>c</sub>
Action not allowed	1.6	1.1 <sub>a</sub>	2.3 <sub>b</sub>	2.3 <sub>c</sub>
Total	100	100	100	100

PA, physical activity; LPA, light PA; MVPA, moderate-to-vigorous PA; VLPA, very light PA. A different subscript letter denotes a subset of PA categories whose column proportions differ significantly from each other at the 0.05 level.

**TABLE 2:** Proportions of the physical activity intensity levels in children's activities ( $N = 57\,881$ ).

Children's activities	PA intensity levels			Total %
	VLPA %	LPA %	MVPA %	
Physical activities	5	34	61	100
Rule play	54	23	23	100
Action not allowed	39	45	16	100
Role play	35	54	11	100
Hanging about	39	51	10	100
Other action	44	47	8	100
Material play	54	40	5	100
No focus	50	46	5	100
Task or seatwork	81	17	2	100
Daily routines	78	21	1	100
Reading	92	8	1	100

PA, physical activity; LPA, light PA; MVPA, moderate-to-vigorous PA; VLPA, very light PA.

activities, material play generated LPA reasonably well. Task or seatwork and no focus together accounted for almost one-fifth of the children's day, but < 5% of all MVPA occurred in these two of children's activities (Table 1 and Table 2).

The five least common children's activities (Table 1) took altogether about 17% of the children's time. Of these, we observed rule play to be the second most effective in raising high PA in the whole sample (Table 2). Similarly, action not allowed and hanging about proved to activate children efficiently in LPA and reasonably well in MVPA. Children were rarely observed in action not allowed, but when it occurred, they were highly active (Table 1 and Table 2).

To summarise, the most efficient prompts for MVPA in the whole sample were physical activities, rule play, action not allowed and role play. Particularly low proportions of MVPA were observed in task or seatwork, routines and reading. Furthermore, children spent almost 50% of their time in these three activities.

### Differences between genders

Firstly, boys had 3% more high PA compared with girls (12.7% in boys vs. 9.5% in girls), who seemed to prefer lower intensity activities (LPA 30.8% in boys vs. 31.9% in girls) (VLPA 56.5% in boys vs. 58.5% in girls). Physical activities appeared to best generate MVPA in both genders are presented (Table 3). However, it seemed to be a more important source of MVPA for girls because they obtained 5% more of their MVPA in physical activities compared with boys, but only 10% of girls' and 11% of boys' observations were found in physical activities. Boys were observed more often in rule play and action not allowed, which provoked MVPA in both genders, specifically in boys. Girls in turn engaged more in hanging about and gained more MVPA in it. Girls engaged more in role play, but of all observations in MVPA the proportion in role play was similar in boys and girls (Table 3).

Girls spent more time in routines, which did not generate MVPA for either gender. In addition, girls did more task or

**TABLE 3:** Proportion of all observations in children's activities and proportion of moderate-to-vigorous physical activity between genders (boy  $n = 26\,522$ , girl  $n = 23\,767$ ).

Children's activities	All observations		Observed MVPA	
	Boy (%)	Girl (%)	Boy (%)	Girl (%)
Daily routines	32.0 <sub>a</sub>	33.8 <sub>b</sub>	2.8 <sub>a</sub>	3.1 <sub>a</sub>
Physical activities	11.2 <sub>a</sub>	10.3 <sub>b</sub>	57.4 <sub>a</sub>	62.8 <sub>b</sub>
Material play	11.3 <sub>a</sub>	9.9 <sub>b</sub>	5.9 <sub>a</sub>	4.3 <sub>b</sub>
Role play	9.6 <sub>a</sub>	10.8 <sub>b</sub>	10.1 <sub>a</sub>	9.9 <sub>a</sub>
Task or seatwork	9.3 <sub>a</sub>	10.6 <sub>b</sub>	1.0 <sub>a</sub>	2.1 <sub>b</sub>
No focus	8.2 <sub>a</sub>	8.2 <sub>a</sub>	3.5 <sub>a</sub>	3.2 <sub>a</sub>
Reading	4.7 <sub>a</sub>	4.6 <sub>a</sub>	0.2 <sub>a</sub>	0.4 <sub>a</sub>
Rule play	4.9 <sub>a</sub>	3.9 <sub>b</sub>	11.0 <sub>a</sub>	6.7 <sub>b</sub>
Hanging about	4.0 <sub>a</sub>	4.4 <sub>b</sub>	3.1 <sub>a</sub>	4.5 <sub>b</sub>
Other action	2.4 <sub>a</sub>	2.4 <sub>a</sub>	1.5 <sub>a</sub>	1.8 <sub>b</sub>
Action not allowed	2.3 <sub>a</sub>	1.0 <sub>b</sub>	3.3 <sub>a</sub>	1.2 <sub>b</sub>
Total	100	100	100	100

A different subscript letter denotes a subset of boy or girl categories whose column proportions differ significantly from each other in all observations and in MVPA at the 0.05 level. MVPA, moderate-to-vigorous physical activity.

seatwork than boys and it did not provoke MVPA in boys but in some girls. Instead, boys were observed more often and to be more efficacious in material play. No difference was found in no focus, which was rather prevalent but not highly activating. Both genders were observed as often in reading, which included the least MVPA. The proportions of all observations were similar between genders in other action but the proportion of MVPA was slightly higher in girls compared with boys (Table 3).

## Discussion

Our data support the previous findings that preschool children spend a large proportion of their day in basic care (e.g. dressing, hygiene, resting) and in transition (Brown et al. 2006; Reunamo & Kyhälä 2016; Vitiello et al. 2012). The most prevalent of children's activities, routines, was the poorest instigator of MVPA, which is consistent with Reunamo and Kyhälä (2016) and Brown et al. (2006). Routines, material play and task or seatwork took over half of children's time, which is in line with Early et al. (2010), Reunamo et al. (2014a) and Reunamo and Kyhälä (2016). Concurrently, almost 70% of VLPA and < 10% of MVPA occurred in these actions. On the other hand, naps were included in routines, which make the VLPA proportions higher in the present study. Naps are important and beneficial and they cannot be diminished, but even so, the rest of routines should include MVPA in short pulses spread throughout the ECEC day. The difference between genders in time spent in activities was most evident in routines. The reason why girls spent more time in routines may be, for example, congenital preferences or early reinforcement of gender-stereotyped patterns of interest as Early et al. (2010) suggested, although they did not find any systematic providing of different experiences for children based on gender. However, the higher proportion of time spent in routines was not related to girls' higher level of MVPA-observations in routines in this study. The educators should pay attention to the high proportions of time in routines and the difference between genders in it. For example, playing 'Simon Says' and 'Follow the Leader' in the waiting situations and transitions, or in other routines,

would increase short pulses of MVPA evenly throughout the ECEC day.

*Material play* (inside and outside), as popular and poorly activating, should be targeted. This is in line with Reunamo et al. (2014a), who found that children engaged highly in play with toys and materials inside and outside but were rarely involved in MVPA. Previous reviews have indicated that materials and toys that are associated with high PA (e.g. wheeled toys) may be more suitable for boys' preferences (Hodges et al. 2013; Todd et al. 2017; Tonge et al. 2016), and may explain why boys engaged more in *material play* and gained more MVPA in it compared with girls. Further studies are needed to explore the toys and materials that would generate MVPA in girls. The size and weight of the toys should be explored, also, for example, whether the common toys and materials (bricks, shovels and buckets, etc.) could be PA promoters if bigger and heavier, so that children could exert themselves when using them.

Children develop their pre-academic skills often during *task or seatwork* and *reading*, which were very sedentary and poor in arousing MVPA. Interestingly, as in *routines*, boys engaged less than girls in *task or seatwork*. However, as suggested earlier (Tonge et al. 2016; Ward et al. 2009), integrating PA across the curriculum would promote MVPA in both genders. In *reading* sessions (the least active activity), the educators could, for example, invite children to *role play*, adapted to the story. When doing mathematics within *task or seatwork*, physical exercise should be frequently integrated into the tasks being performed and in *reading* – not only for the PA itself but also for its positive consequences for children's on-task behaviour, involvement, academic achievement and cognition (e.g. Diamond 2015; Fedewa & Ahn 2011; Laevers 1994). We propose that a gym or another room with a big open space would offer great chances for academic preschool lessons integrated with PA.

*Physical activities*, *rule play*, *action not allowed* and *role play* aroused MVPA most effectively (in this order), which is consistent with Reunamo et al. (2014a). Interestingly, *physical activities* were more important for girls than for boys in generating MVPA, although boys engaged more in it. Boys engaged more in *rule play* also and gained more MVPA in it. Indeed, Nilsen, Anderssen and Resaland (2019) hypothesised boys favouring outdoor highly active play, which appears often in the form of *rule play*, such as ball games and competitions. Although boys gained more MVPA in *rule play*, it can be considered a very important source of MVPA in girls too. It is possible that educators' own beliefs and behaviours – with gender stereotyping – may inadvertently influence the activities children take part in (Hesketh, Lakshman & Van Sluijs 2015) or even educators may support highly activating *rule play* more in boys than in girls (Pate et al. 2004). We believe that girls' MVPA could be increased if they were equally encouraged to be highly active, for example, by teacher-led organised *rule play* (Olesen et al. 2014; Sansolios & Mikkelsen 2011). *Rule play* was contradictory because it included both

sedentary and physical play and games with rules, but overall, it was very efficacious in arousing MVPA. However, age appropriate and physically active *rule play* can be considered valuable in enhancing MVPA.

Pellegrini and Smith (1998) stated that girls tend to revolve around domestic and dramatic fantasy play, which may explain why girls engaged more in *role play* compared with boys, whilst the proportion of MVPA was similar in both genders. Brown et al. (2009) found no significant association between children's PA and sociodramatic props, but it is possible that girls would benefit from a variety of highly activating materials in *role play* because they obviously favour it. We believe that the available *role play* material provokes especially boys' MVPA and should be regarded in relation to its ability to provoke MVPA in girls too. In addition, girls could be guided to more exerting *role play* instead of the traditional gender-stereotyped activities.

Certainly, a good finding was that *action not allowed* proved to be rare, but interestingly it was amongst the best MVPA generators, as found earlier by Reunamo et al. (2014a). Instead of denials, training of educators to encourage children in safe PA would be more advantageous for children's well-being. Boys have been reported to participate more in risk-taking behaviours and rough and tumble play (DiPietro 1981; McIntyre & Edwards 2009; Pellegrini & Smith 1998), which are often forbidden in ECEC. In this study, boys engaged more in *action not allowed* than girls did. However, consistent with Reunamo et al., it was one of the best MVPA generators in both genders. We believe that there are many unnecessary denials impeding children's PA. Educators should discuss the practices in their own ECEC environment. Perhaps some of the *actions not allowed* should be allowed.

Some MVPA was discovered in *hanging about*, which is in line with previous findings of peers provoking MVPA (Reunamo & Kyhälä 2016; Ward et al. 2016). In the present study, it awoke MVPA specifically in girls (fourth most efficacious action in girls and fifth in boys). Consistent with Olesen et al. (2014), our findings (girls' higher time spent in and higher MVPA level in *hanging about*) suggest that girls' MVPA might benefit from the presence of their peers. On the other hand, the high proportions of time spent in *hanging about* and *no focus* support the idea that children spend large proportions of their time unoccupied (Early et al. 2010) or in non-goal-directed activities (Winsler & Carlton 2003). This issue should be observed. If the length of a child's ECEC day is 6 h, he or she spends about 30 minutes without focus. For example, there could be an activity dice or an activity card that tells children what to do.

Finally, boys and girls spent different proportions of time in various activities as found earlier (Early et al. 2010; Reunamo et al. 2014a; Reunamo & Kyhälä 2016). Consistent with previous studies (e.g. Lindsay et al. 2017; Tonge et al. 2016), boys obtained more MVPA than girls did, in total. Boys engaged more in the most efficacious actions, except for *role play*. Therefore, educators should consider their own action

modes and promote high PA in both genders. Because of the high percentage of girls' observed MVPA in physical activities, the educators should encourage girls to engage frequently in physical activities. Both boys and girls should be steered into *physical activities*, *rule play* and *role play* during all general activities in ECEC.

## Strengths and limitations

This research gives new information about young children's PA patterns by offering data about children's time use in children's own activities and the ability of these activities to generate MVPA. A strength of the present study is the large sample size with 2879 children in 13 municipalities and 57 881 observations.

Nevertheless, the present investigation has limitations. Firstly, accelerometer-based measurements would have offered more accurate information. Secondly, it is possible that some MVPA has not been recognised because of the observation epoch of 1 minute. However, the observers were instructed to select the most prevalent intensity level in the epoch. Thirdly, there were more observations in the mornings in comparison with the afternoons. More resting in the afternoons may have resulted in more MVPA in the morning. The emphasis on the morning observations may bias the results considering that children may spend the whole day in preschool. To check this the effect to the statistical significance, we weighted the afternoon observations by six. The statistical significance did not change after the weighting. Fourthly, the municipalities participated differently in this study, which might have biased the results. A limitation may be that we included sedentary and physically active behaviours in *rule play* and *material play*. Separating them would have enabled more conclusions about the results.

## Conclusion

Our results supported the previous findings that children spend much of their ECEC time waiting, following instructions and doing what they need to do. Three prevalent actions: *routines*, *material play* and *task or seatwork*, with insufficient proportions of MVPA, accounted for over half of the children's ECEC day, being responsible for over two-thirds of VLPA. As boys seemed to find more occasions for MVPA than girls did, girls should be helped and encouraged to see opportunities for it, too. However, these data do not explain to what extent the proportions of all observations or MVPA are caused by either children's own preferences and selections or the teachers' decisions and gender stereotypes.

We assume that children's MVPA could be increased and VLPA decreased in two ways: (1) through increasing opportunities to engage in the most efficacious activities: *physical activities*, *role play* and *rule play* (scarce but efficacious) and (2) by modifying the least effective but prevalent activities to be more physically activating. Young children need MVPA throughout the day, and the ECEC educators are crucial in

promoting it. To enhance professional development, the educators need more knowledge of MVPA and skills in implementing MVPA activities across the curriculum.

Future studies should explore whether there are differences between ECEC centres in the present research questions and what causes them. In addition, the highly activating features of *action not allowed* need to be identified in the future.

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The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

### Authors' contributions

J.R. planned and developed the project and performed the data collection. A-L.K. wrote the article under supervision and guidance of J.R. and J.O.V. assisted with data interpretation.

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### Data availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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