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Preschool group practices and preschool children's sedentary time: a cross-sectional study

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Abstract

objectives: Preschool is an important setting for promoting children's active movement behaviors and regulating sedentary time (ST). The preschool day in Finland follows daily structures and routines by having morning and afternoon slots for group-based activities that can be divided into physical (e.g., free play, outdoor time, field trips) or non-physical (e.g., teacher-led sessions, sitting-based circles). In addition, preschool time may be spent in different places that encourage PA, such as forests or playparks. The study aims to explore if the weekly routines in preschool group are associated with children's ST, and if more frequent visits in places encouraging PA are associated with children's ST.

design: Cross-sectional.

setting: In years 2015 and 2016 in Finland.

participants: 864 children from 159 preschool groups in 66 preschools

outcome measures: A total of 778 children wore required lengths of time the accelerometer during preschool hours. Each preschool group reported their weekly schedule during the measurement week, and one early educator completed questionnaire covering preschool group practices. Multilevel linear regression analyses were conducted to measure the associations between preschool group practices and children's ST.

results: Of all the tested associations, only more frequently conducted forest trips were associated with lower children's ST during preschool hours.

conclusions: Providing frequent access to nature may be important due to its association with lower preschool children's ST. More study is needed to understand the role of preschool in children's ST.

Keywords: sedentary lifestyle, preschool, children, physical activity

An Article Summary

Strengths and limitations of this study:

- The major strength of this study is that we measured the associations between multiple places encouraging for PA and children's ST instead of measuring total outdoor time or combined indicators of activities
- The another strength of this study is that we had the information collected from the preschool groups regarding time-stamped weekly practices during the week when children wore an accelerometer.

- The limitation of this study is that the hip-worn accelerometer may not effectively separate standing from sitting and reclining positions.
- The another limitation of this study is that we did not receive weekly programs from all the participating groups (the drop-out rate was 40%).

INTRODUCTION

Preschool-aged children, roughly three to five years, are commonly assumed as being inherently active, moving throughout the day mainly in random and intermittent ways (e.g., unstructured active play). However, contrary to expectations, multiple recent studies have indicated that many children of this age are highly sedentary. For instance, a recent meta-analysis states that preschool-aged children spend approximately 50% of their waking hours in sedentary behavior [1]. Sedentary behavior (SB) is defined as any waking behavior characterized by an energy expenditure less than or equal to 1.5 metabolic equivalents (METs) while in a sitting, reclining or lying posture, whereas sedentary time (ST) is defined as the time spent in sedentary behaviors [2]. Each child needs to engage in some SB every day; however, both promoting SB habits in short bouts and limiting prolonged ST may be important for the primary prevention of obesity [3, 4]. As many other health behavior habits, SB habits tend to track from early childhood to later in life, thus predicting future health behaviors [5]. The preschool-age period may therefore serve as an ideal timeframe for minimizing ST and promoting more active movement behaviors such as physical activity (PA).

Widely encouraged is better recognizing the setting-specific correlates of children's ST [6]. Alongside home, the preschool setting plays an important role in shaping children's behavior. This role is due to the preschool setting being where most children of this age group spend the majority of their waking hours. In Finland, approximately 80% of children aged three to five with different socioeconomic backgrounds attend preschool in approximately similar rates to other OECD countries [7]. According to a recent review, which was based on 55 studies conducted in preschool-type settings, children's ST ranged between 12 minutes and 55 minutes per hour in preschool. Children in preschool may also be more sedentary than children cared for at home, although opposite results have also been found. [1, 8] The variation in these results stresses the significance of understanding which factors are associated with preschool children's ST.

Following the socioecological model of SB, a setting is the physical and social context where ST occurs [9]. The amount of ST in different behavior settings likely has distinct correlates because

both the attributes of the setting and the social frame around this setting shape behavior [9, 10]. For instance, home and preschool are different types of settings regarding how much ST in these settings involves individual choice and how much involves environmental and social constraints. According to this viewpoint, multiple social constraints, norms and structures concerning expectations of sitting (e.g., morning circles, group-activities) may encourage ST in the preschool setting, whereas in the home-setting, children may have more individual choice concerning ST and parental expectations and norms define the extent of ST [4, 10]. Few preschool interventions have successfully decreased children's ST due to the typical pre-planned and routine-based structures in preschools. Therefore, the allocation of overall children's ST may remain unchanged. [11] Our previous qualitative work among preschool personnel supports this view. Preschool personnel recognized both social situations (e.g., children sit when teachers tell instructions in PA lessons) and structured daily activities (e.g., meal-times, group sessions) in the preschool that require sitting [12]. Similarly, other studies noticed that the regular structures in the preschool setting supports certain appropriate behavior leading to school-type behavior [13-15]. Also examined was the little influence that factors in preschool-setting have in explaining the variance in children's movement behaviors [16].

In Finland, the preschool day tends to include structured periods of learning, playing, and rest; these structured daily and weekly schedules are followed throughout the year. Each preschool day includes three meal times and usually an afternoon naptime. In aiming to reduce children's ST in Finnish preschool, the in-built daily structure allows two suitable time slots for activities: between breakfast and lunch (morning slot) and between afternoon snack and the end of the day (afternoon slot). The activities conducted in these slots can be divided into physical (e.g., free play, outdoor time, PA-related field trips such as forest trips) or non-physical activities (e.g., sitting-based circles, teacher-led activities requiring sitting). Understanding how these daily or weekly structures influence preschool children's ST may be beneficial in informing research and practitioners in the field. To the best of our knowledge, no such previous studies have been conducted. This information on daily structures in preschool is relevant as Finnish preschool-aged children are typically only vigorously physically active for approximately 10 percent of each preschool day in Finland, and are physically active at any intensity level for less than 50% of their daily time outdoors [17].

One of the key elements in the Finnish preschool weekly schedule is outdoor time, which is spent either in the preschool's own yard or in conducting trips to nearby facilities that encourage PA.

Preschool children tend to be less sedentary during outdoor-time in preschools than indoors, according to recent meta-analyses [1, 18]. However, less information exists on whether all forms of outdoor activities are similarly associated with higher PA and lower ST [19]. A qualitative study observed that children have higher PA levels during preschool time in a natural environment than in a preschool's outdoor play spaces [20]. Dowda et al, however, discovered that higher numbers of field trips were associated with higher moderate-to-vigorous PA levels, although the association was not significant regarding ST [21]. Early educators consider also that organizing PA-related field trips is a potentially good method of diminishing children's ST in preschools [22]. These mixed results underline the importance of studying whether all types of outdoor activities in preschool similarly influence children's ST.

The aim of this study is twofold: a) to study the associations between weekly routines in preschool (e.g., times of outdoors, teacher-led sessions, free play) and children's ST and b) to determine the existence of associations between more frequent visits to places encouraging PA (e.g., frequency of visits in nature or gym and field trips to neighborhoods) and children's ST.

METHODS

Study context

Municipalities are responsible for organizing preschool education for children in Finland. All children have the right to a preschool place for at least 20 hours a week. Preschool children are enrolled in formal childcare for an average of 30 hours or more per week [23]. Preschool care in Finland is subsidized; the maximum monthly fee is €290 (as of 2018). Family income and family size are accounted for in determining the fee. Compulsory pre-primary education, in preparation for official schooling, begins at the age of six. [24]

The Finnish preschool system is based on the learning-by-playing model. Following the current Finnish national early-childhood policy, preschools should offer stimulating physical environments for children's active play and the development of healthy lifestyles, both indoors and outdoors. Children usually have access to different types of equipment, including both physical activity equipment and sedentary alternatives. In addition, most of the preschools in Finland have access to natural environments and large outdoor play spaces; additionally, preschools commonly conduct trips to nearby areas that encourage PA (such as athletics field and forest) [24].

Study design and population

The DAGIS (Increased Health and Wellbeing in Preschools) study is a long-term project. More detailed information on the whole DAGIS study consortium can be read elsewhere [25, 26]. Part of this project involved conducting a cross-sectional study between autumn 2015 and spring 2016. This cross-sectional study aimed to investigate socioeconomic differences in children's energy-balance related behaviors. This multiple-method study covered children, parents and preschools. Municipalities with a larger variety in education and income levels were selected according to national statistics [27]. A total of eight municipalities (of eleven contacted municipalities) were willing to participate in the study. Preschools in these municipalities were randomly invited to participate. The number of invited preschools was based on power and sample size calculations. The main recruitment criterion for the preschools was the existence of at least one preschool group with children aged three to six. Purely pre-primary education groups for six-year-olds were not included in the study sample. In the chosen municipalities, eighty-six preschools (56% of those invited) gave permission for conducting the study in their preschools. Exclusion from the study concerned sixteen preschools (19% of preschools willing to participate), either because their official spoken language was neither Finnish nor Swedish or because they were open 24 hours a day. In addition, we excluded preschools in which less than 30% of the children in one preschool group participated in the study. Of the consenting preschools, twenty failed to reach the required 30% participation rate. The study was conducted in sixty-six preschools (39 % of those invited). These preschools had a total of 159 preschool groups with children aged three to six.

Preschools recruited children and families. A total of 983 parents (27% of contacted parents) gave written permission for their child to participate in the study; however, 91 parents had a child in a preschool with less than the 30% participation rate. In addition, 28 children had no data that could be used. Consequently, a total of 864 (24% of invited) children (in 39% of the invited preschools) participated in the study. A parent or legal guardian of each participant provided an informed consent. The University of Helsinki Ethical Review Board in the Humanities and Social and Behavioral Sciences approved the study procedures (6/2015, approved in 25th February 2015).

MEASURES

Children's sedentary time

Children's ST was measured using an Actigraph W-GT3X accelerometer (Actigraph, LLC, Fort Walton Beach, Florida). Actigraphs have been validated and extensively used as an objective measure of PA and ST [28-31]. Research assistants set the accelerometer on children's hips on the first day of the measurement. Following data collection, the epoch length was set at 15 seconds. Periods of 10 minutes or more at zero accelerometer counts were considered non-wearing times and were excluded. Possible nap-times were not excluded. The analyses involved applying the Evenson ST cut-point (0–25 counts per 15 seconds) [32], a good estimate of free-living ST [33]. Parent-provided information about daily preschool hours were applied to separate the preschool hours from the overall accelerometer data. For inclusion in the analyses, we expected that children attended the preschool for at least 240 minutes per day for at least two days of the study period. Preschool hours varied between children, thus the variable was adjusted for the preschool wearing hours. Therefore, the measure used in this study indicates the children's ST minutes in one hour in preschool.

Preschool setting

Weekly programs

Early educators in preschool groups completed a program of their activities during the week that children in their group wore an accelerometer. This program was a semi-structured sheet, with the times of the day listed in rows in the first column and each day (Monday to Friday) separated into its own column. Each day had breakfast, lunch, nap time, and afternoon snack ready-written on the sheet. Educators were asked to write the activities the group had conducted in the empty rows on the time slots between breakfast and lunch (morning slots) and between afternoon snack and the end of the day (afternoon slots) .

This information was recoded into measures as follows. Most of the preschool groups usually conducted two activities in each session (morning/afternoon), therefore, we categorized two activities for the morning session and two for the afternoon session. These activities were categorized into five main groups based on the educators' reported activities. The following five main categories were grouped: 1= outdoors (all activities conducted outside, either in their own yard or on field trips), 2= Teacher-led sessions (all activities that mainly required sitting, and teacher-led activities in the group such as morning circles, craft making and reading circles), 3= free play (when children played alone or with other children without an adult initiating, facilitating or organizing the play), 4=PA lesson (organized PA lesson either outside or inside, although clearly being a teacher-led, organized lesson), and 5= mixed sessions (the group had conducted multiple different activities in smaller groups and these smaller groups had alternated the activities). We

calculated the daily number of each activity. This number was summed up for the week level; we expected to find at least three days with full details of activities. This score was then divided by the number of the days (from three to five) to form the average daily amount of each activity.

Questionnaire related to group practices

One early educator in each group completed a questionnaire related to practices and regulations of children's health behaviors in their preschool group. The questionnaire was based on previously used questions and items that had been adjusted for the Finnish preschool context [12, 34, 35]. One of the questions in this questionnaire related to PA possibilities. Firstly, the early educator was asked to report which of the following places encouraging PA are close to the preschool (easy and short walk for children). The questionnaire had a total of nine answer options: nature, play park, neighborhood sport facility, gym (situated outside of preschool), ball court, athletics track, ski tracks, slopes and ice rink. This study uses only the first four options, as these options tend to happen more often and are not dependent on specific seasons (for example, skiing requires snow). In addition, a separate question in the questionnaire asked if the group conducts field trips to neighborhoods and how often.

If an early educator reported 'yes, there is a place nearby', the following questions asked in more detail if it is used (yes/no) and how often. The frequency was measured in a semi-structured way, with options given to the early educator regarding the number of times and selected time frequency: per week/month/year.

These questions were recoded to a suitable timeframe. If an early educator reported that no facility exists nearby, it was recoded to zero. Similarly, if an early educator reported that a facility exists nearby but is not used, it was recoded to zero. Frequencies of visits to these facilities were recoded to times per week. These measures were used in the analyses either as continuous, dichotomous or categorical, depending on the distribution. Table 1 indicates the used form of measure.

Covariates

The analyses' covariates were children's age, gender, average attendance at preschool and study season. Children's attendance at preschool was a composite score of the answers of their guardian's questionnaire: How many days per week does your child attend preschool? and how many hours per day does your child usually attend preschool? Combining these items enabled illustrating children's attendance at preschool regarding their daily average hours in preschool (hours/day). The study season measure was divided into three categories: 1=September–October, 2= November–December, and 3=January–April.

Statistical analyses

The descriptive statistics were checked using the SPSS statistical program version 24 (SPSS Inc.,Chicago, IL, USA), whereas the multilevel linear regression models were run using the Mplus program version 7.14 (Muthen & Muthen,2018). All analyses were adjusted for each child's age and gender, average preschool hours, and measurement season; analysis concerned the individual associations of each preschool group practice. The most appropriate statistical method uses multilevel models when focusing on group-level effects and their association with individual-level variables in data sets involving persons nested in groups, such as children attending the same preschool group. In the analyses, children were designated as the first-level unit, and preschool groups as the second-level unit [36]. Each individual-level independent variable (child's age and gender, average preschool hours) was group-mean centered [37]; the estimator in the analyses was MLR (maximum likelihood with robust standard errors).

RESULTS

Of the 864 participating children, 48% were girls, the average age of participants was 4.7 years (standard deviation 0.89) and the children spent on average 34.6 hours per week in preschool (standard deviation 8.8). Of these participating children, a total of 821 children (95% of the participants) had some accelerometer data to use in forming the variables, and of them, 778 had the required amount of accelerometer data for preschool hours. The average ST measured in the preschool by accelerometers was 26.47 minutes per hour (standard deviation 5.10 minutes).

Of the 159 possible groups (82% response rate), a total of 131 preschool groups completed the weekly programs. Of this total number, 96 groups had complete information on their activities from at least three days (73% of the possible programs). In addition, 146 of early educators returned the preschool group questionnaire (92% response rate). On average, the preschool groups had six nearby PA facilities out of nine possible measured facilities (standard deviation 1.9). Collected in early autumn (September – October) was approximately 44% of the data (n=379 children); collected in late autumn (November – December) was 36% of the data (n=310 children); collected in spring (January – April) was 20% of the data (n=175 children).

Table 2 presents the results of our multilevel linear regression analyses. Only the more frequently conducted forest trips were associated with children's lower ST. No other significant associations were found between preschool group practices and children's ST.

DISCUSSION

This study aimed to determine both the associations between weekly routines in preschool and children's ST and the existence of associations between more frequent visits to places that encourage PA and children's ST. Of all the tested associations, we identified associations between more frequently conducted forest trips and lower children's ST.

Associated with lower children's ST was more frequently conducted nature trips in preschool, the only significantly associated factor identified in our study. Other studies have also highlighted that playing in natural environments not only increases children's PA levels, but also positively affects children's health, wellness, learning and development, making it a valuable habit to learn in early childhood [38-40]. Potential explanation for children's lower ST levels in nature is that nature challenges all children in different ways, compared to the preschool setting with built outdoor yards. Nature does not offer direct environmental cues for sitting, rather nature offers possibilities for open movement and flexibility. Children who regularly attend preschool may get bored with the same daily alternatives for playing in the preschool yard and PA opportunities in a yard may be less challenging; nature, however, challenges children's imagination differently and diversely [41]. Fixed playground equipment often involve closed or fixed ways of moving and can encourage more sedentary-type activities (e.g., sandboxes and swings are typical equipment in a yard). Therefore, nature may be especially important for children who tend to play more passively in playgrounds [20]. Nature seems to encourage all children, despite their age, size or other personal characteristics, to get involved in creativity and spontaneous exploration; thus all children may easily discover their own type of active play [20, 42, 43]. Consequently, developing public health strategies that increase nature visits at an early age is relevant. Additionally important is determining whether all kinds of outdoor activities play a similar role in children's movement behaviors. Measuring the length of outdoor activities in each preschool group was impossible in our study; this may be a relevant factor, however. Children may have short intense bouts of activity, lasting less than 15 minutes, at the start of outdoor free-play periods in a preschool yard following extended periods of ST. Breaking outdoor times into shorter periods of time may be more beneficial [18, 44, 45].

Our study examined the associations between multiple weekly or daily structures and children's ST during the same measurement week. However, none of the measured weekly practices were significantly associated with children's ST. Other studies have found similar results [14, 16, 46]. A comparative study between preschools in the USA and Sweden found differences in daily routines and the supervision of children's behaviors at preschools. In the USA, rules, routines and adult leadership caused children to interrupt their ongoing activity, and many of the everyday routines were associated with children either being instructed or encouraged to stay inactive. However, Swedish preschools had shorter periods of mandatory or encouraged SB periods, with mainly one to two daily teacher-led sessions involving all children, during which they sit in a circle on the floor and were expected to stay calm [14]. In the UK, Hesketh et al. discovered the limited influence of preschool environment on children's movement behaviors, with children's individual activity preferences playing a bigger role [16] . To summarize these comparisons with the results of our study, a less structured preschool day may result in the preschool environment exerting a smaller influence on children's movement behaviors. Therefore, differences in children's ST concern other factors, for example, children's individual characteristics. Overall, these different findings between studies highlight sociocultural differences between countries, which should be better accounted for when developing methods to measure factors associated with children's ST in preschool settings.

We did not measure the actual content of each these measured daily structures. For instance, we do not know what children actually did when they were outside or had free-play sessions. During the free-play sessions and outdoor time, children can usually choose from a range of multiple options, from sedentary alternatives to more PA-related equipment. Previous studies have indicated that children's individual characteristics, for instance gender and temperament, are associated with children's ST in preschool [1, 47, 48]. Consequently, early educators may have little control over the type of activity a child partakes in during free-play or outside sessions, as children's individual characteristics may play a bigger role. Notably, children self-select their own activities daily, meaning that one day they may choose more sedentary activities, whereas another day, more physical activities [16]. Studies have shown that children spend less than 50% of time in PA during free-play periods, suggesting that adding structure to these periods may increase the amount of PA [11, 49, 50]. Structure could involve providing equipment for children with instructions on how to use the equipment, or teachers' prompts, encouragement or playing together with children [11, 50]. Interestingly, children with low levels of PA may benefit from this structured-type of free play, whereas the most active children often benefit more from having less structure [50]. Thus, each child needs to learn to sit still and develop their cognitive and self-regulation skills during their

preschool years, but more essential is discovering how to break children's ST and find optimally short bouts of ST during preschool hours. Therefore, studying the role of children's individual characteristics may be necessary in explaining children's ST.

Early educators play an important role in determining ST and PA; however, socially relevant is the other children in the preschool group and their influence on children's behavior. Over time, children's PA and dietary intake tend to become similar to their peers' levels in a preschool group [51]; children's PA levels are often higher in the presence of peers [52]. A recent study observed that the most active children tend to seek other physically active children, whereas children who are introverted or who may not have close friendships with their peers may feel uncomfortable or excluded and revert to low- intensity physical activities [50]. Teacher-led sessions are usually pre-planned, with guided participation of children; all the children in a group usually conduct similar activities, allowing less freedom for children's individual choice of activities [13]. However, other studies support teacher-led activities, claiming they increase children's movement and activity levels compared to free-play sessions [48, 53, 54]. Therefore, essential is determining the most effective type of social influence, adult-initiated or child-initiated, in decreasing children's ST. For instance, children with particular temperament traits may benefit more from adults' than peers' role modelling.

Our study introduced novel knowledge by studying the organizational factors associated with children's ST; this is essential information according to a recent review[55]. An additional strength of our study concerns the information collected from the preschool groups regarding time-stamped weekly practices during the week when children wore an accelerometer. We measured the associations between multiple places encouraging for PA and children's ST instead of measuring total outdoor time or combined indicators of activities. The novelty of this study concerns the information provided on whether all types of PA places similarly decrease children's ST. The random selection technique enabled our study sample to cover large and small preschools situated in both urban and countryside environments in different municipalities. Therefore, our sample widely represents activities conducted in Finnish preschools, simultaneously preventing a limited focus on certain areas (e.g., urban). However, our study had some shortcomings. We did not receive weekly programs from all the participating groups and the drop-out rate (40%) was quite high; we cannot estimate the reasons for this non-response. We could not measure the actual length (in minutes or hours) of the weekly practices to allow measuring whether differences existed in the lengths of activities between preschools. Although accelerometers are commonly used and can

measure children's movement behaviors in free-living conditions, notably, accelerometers cannot always distinguish between sitting and standing. Additionallly, differently used cut-points and data reduction methods may influence the dissimilarity in the results of different studies. The cross-sectionality of this data does not allow drawing conclusions on the causality of the studied associations. Important to notice is the existence of multiple unexplored social- and individual factors that may affect children's preschool behavior at this age, requiring further investigation with high quality and reliable measures.

CONCLUSION

This study assessed whether preschool weekly routines are associated with children's ST, and whether more frequent visits to places encouraging PA are associated with children's ST. Of the tested associations, more frequently conducted nature trips were associated with lower children's ST. Nature may challenge children to use their creativity in various activities, and also encourages all children to walk and take steps in different ways than in the more-structured type of places that encourage PA. Based on our study, routines and structures in the preschool setting have little influence on children's ST. Future studies could determine whether other factors, for instance children's individual characteristics, play a bigger role in explaining children's ST.

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Conflicts of interest: none

Ethics approval: the University of Helsinki Review Board in the Humanities and Social and Behavioral Sciences

Data sharing statement: Researchers interested in the data from this study may contact principal investigator Eva Roos, eva.roos@folkhalsan.fi.

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Table 1. Descriptives of preschool group practices used in the DAGIS study

Preschool group practices			Descriptive	Descriptive	N
Weekly structures					
	Times of outdoor time		Mean 2.45 times per day	Standard deviation 0.69	96
	Times of teacher led sessions		Mean 0.76 times per day	Standard deviation 0.67	96
	Times of free play	Low (not at all)	44.8%	n=43	96
		Middle (between 0.1 to 0.8 times per day)	31.3%	n=30	
		High (between 0.81 to 4 times per day)	24.0%	n=23	
	Times of organized PA lessons	No lessons at all	56%	n=54	96
		Others	44%	n=42	
	Times of mixed activity	No mixed sessions	71%	n=68	96
		Others	29%	n=28	
Frequency of visits to places encouraging PA					
	Frequency of Nature trips		Mean 0.93 times per week	Standard deviation 0.62	138
	Frequency of visits to play parks		Mean .41 times per week	Standard deviation 0.72	139
	Frequency of visits to neighborhood sport facilities	No visits at all	62%	n=85	137
		Others	38%	n=52	
	Frequency of visits to gym or other indoor facility (which is not own)	No visits at all	57%	n=82	143
		Others	43%	n=61	
	Frequency of field trips to neighborhoods		Mean .52 times per week	Standard deviation 0.56	134

Table 2. The associations of preschool group practices and children's sedentary time (min/h) in multilevel linear regression models

			β	Lower 95%CI	Upper 95% CI	N
Preschool group practices						
	Times of outdoor time		-0.259	-1.293	0.776	470
	Times of teacher-led sessions		0.438	-0.797	1.672	470
	Times of free play [1]	Low	-0.655	-2.626	1.316	470
		Middle	-1.206	-3.312	0.901	
		High (reference)				
	Times of organized PA lessons [1]		0.661	-0.730	2.052	470
	Times of mixed activity[1]		-0.635	-1.768	0.497	470
Frequency of visits to places encouraging PA						
	Frequency of nature trips		-1.026	-1.804	-0.248	655
	Frequency of visits to play parks		0.264	-0.278	0.806	649
	Frequency of visits to neighborhood sport facilities [1]		-0.520	-1.558	0.519	654
	Frequency of visits to gym or other indoor facility [1]		0.184	-0.913	1.281	671
	Frequency of field trips to neighborhoods		0.040	-0.909	0.989	647

[1] treated as categorized. All the analyses are adjusted for children's age, gender and average preschool attendance and measurement season.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1	Preschool group practices and preschool children's sedentary time: a cross-sectional study
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2	abstract
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4	Introduction
Objectives	3	State specific objectives, including any prespecified hypotheses	5	The aim of this study is twofold: a) to study the associations between weekly routines in preschool (e.g., times of outdoors, teacher-led sessions, free play) and children's ST and b) to determine the existence of associations between more frequent visits to places encouraging PA (e.g., frequency of visits in nature or gym and field trips to neighborhoods) and children's ST.
Methods				
Study design	4	Present key elements of study design early in the paper	6	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7	a cross-sectional study was conducted between

				autumn 2015 and spring 2016….
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection participants	6-7	A total of 983 parents (27% of contacted parents) gave written permission for their child to participate in the study
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8	Indicators of sedentary behaviors Children wore an Actigraph W-GT3X accelerometer…
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6-8*	Research assistant attached accelerometer to the child's waist in the preschool.
Bias	9	Describe any efforts to address potential sources of bias	6	A major recruitment criterion was that there had to be at least one group of children aged 3-6 in the preschool. Eighty-six heads of preschools (56% participation rate) gave their written consent for participation in the study.
Study size	10	Explain how the study size was arrived at	9	Of these participating children, a total of 821 children (95% of the participants) had some accelerometer data to use in forming the variables,

	and of them, 778 had the required amount of accelerometer data for preschool hours.

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8	Early educators in preschool groups completed a program of their activities during the week that children in their group wore an accelerometer
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8	The analyses were adjusted the child's age and gender…
		(*b*) Describe any methods used to examine subgroups and interactions		
		(*c*) Explain how missing data were addressed		
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	9	The non-independence of observations due to cluster sampling (children in the preschool groups) was taken into account in the analyses,
		(*e*) Describe any sensitivity analyses		
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9	Of the 864 participating children, 48% were girls, the average age of participants was 4.7 years (standard deviation 0.89) and the children spent on average 34.6 hours per week in preschool (standard deviation 8.8).
		(b) Give reasons for non-participation at each stage		
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9	Table 1 and result section
		(b) Indicate number of participants with missing data for each variable of interest		
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures	9	Results sextion

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7	The analyses were adjusted for municipality, the child's age and gender, and the season during which the accelerometer was used…
		(*b*) Report category boundaries when continuous variables were categorized		
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses		
Discussion				
Key results	18	Summarise key results with reference to study objectives	10	This study aimed to
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-13	
Generalisability	21	Discuss the generalisability (external validity) of the study results	13	that it encompasses a large sample, including children from 66 different preschools in various municipalities
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13	This study was financially supported

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Preschool group practices and preschool children's sedentary time: a cross-sectional study in Finland

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Preschool group practices and preschool children's sedentary time: a cross-sectional study in Finland

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Abstract

objectives: Preschool is an important setting for regulating sedentary time (ST). The preschool day in Finland follows daily structures by having morning and afternoon slots for group-based activities that can encourage children for movement (e.g., free play, outdoor time, visits to play parks) or be still (e.g., teacher-led sessions, sitting-based circles). The study aims to explore if the weekly routines in preschool group, and if more frequent visits in places encouraging PA are associated with children's ST during preschool hours.

design: Cross-sectional DAGIS study in years 2015 and 2016.

setting: In Finland

participants: 864 children (48% girls, 4.7 years) from 159 preschool groups in 66 preschools

outcome measures: A total of 778 children wore required lengths of time (at least 240 minutes per preschool day, at least two days) the accelerometer during preschool-hours. Each preschool group reported their weekly schedule during the measurement week, and one early educator completed questionnaire covering practices. The following five measures related to weekly structures were formed; times of outdoortime (times per day), teacher led sessions (times per day), free play (low, middle or high), organized PA lessons (no lessons at all/others) and mixed activities (no lessons at all/others), and following five measures about the frequencies of visits in places encouraging PA; nature trips (times per week), play parks (times per week), neighborhood sport facilities (no visits at all/others), visits to gym or other indoor facility (no visits at all/others) and field trips to neighborhoods (times per week). Multilevel linear regression analyses were conducted to measure the associations between practices and children's ST.

results: Of all the tested associations, only more frequently conducted nature trips were associated with lower children's ST during preschool-hours (β=-1.026; 95% CI: -1.804, -0.248).

conclusions: Frequent nature trips in preschools may be important due to its association with lower preschool children's ST.

Keywords: sedentary lifestyle, preschool, children, physical activity

An Article Summary

Strengths and limitations of this study:

- The major strength is that we measured the associations between multiple places encouraging for PA and children's ST instead of measuring total outdoor time or combined indicators of activities

- Another strength is that we had the information collected from the preschool groups regarding time-stamped weekly practices during the week when children wore an accelerometer.
- The limitation is that the hip-worn accelerometer may not effectively separate standing from sitting and reclining positions.
- Another limitation is that we did not receive weekly programs from all the participating groups (the drop-out rate was 40%).

INTRODUCTION

Preschool-aged children, roughly three to five years, are commonly assumed as being inherently active, moving throughout the day mainly in random and intermittent ways (e.g., unstructured active play). However, contrary to expectations, a recent meta-analysis states that preschool-aged children spend approximately 50% of their waking hours in sedentary behavior [1]. Sedentary behavior (SB) is defined as any waking behavior characterized by an energy expenditure less than or equal to 1.5 metabolic equivalents (METs) while in a sitting, reclining or lying posture, whereas sedentary time (ST) is defined as the time spent in sedentary behaviors [2]. Every child needs to engage in some SB every day; however, promoting SB habits in short bouts and limiting prolonged ST may be important for the primary prevention of obesity [3, 4]. Like many other health behavior habits, SB habits tend to track from early childhood to later in life, thus predicting future health behaviors [5]. The preschool-age period may therefore serve as an ideal timeframe for minimizing ST and promoting more active movement behaviors such as active play and physical activity (PA).

Widely encouraged is better recognizing the setting-specific correlates of children's ST [6]. Alongside home, the early childhood education and care setting such as preschool plays an important role in shaping children's behavior. This role is due to the preschool setting being where most children of this age group spend the majority of their waking hours. In Finland, for instance, approximately 80% of children aged three to five with different socioeconomic backgrounds attend preschool in approximately similar rates to other OECD countries [7]. According to a recent review, which was based on 55 studies conducted in preschool-type settings, children's ST ranged between 12 minutes and 55 minutes per hour in preschool[8]. Another review stated that the proportion of time spent in overall ST (despite the context) ranged from 34% to 94% between studies [9]. Children in preschool may also be more sedentary than children cared for at home, although

opposite results have also been found [1, 8] The variation in these results stresses the significance of understanding which factors are associated with preschool children's ST in the preschool setting.

Following the socioecological model of SB, a setting is the physical and social context where ST occurs [10]. The amount of ST in different behavior settings likely has distinct correlates because both the attributes of the setting and the social frame around this setting shape behavior [10, 11]. For instance, home and preschool are different types of settings regarding how much ST in these settings involves individual choice and how much involves environmental and social constraints. According to this viewpoint, multiple social constraints, norms and structures concerning expectations of sitting (e.g., morning circles, group-activities) may encourage ST in the preschool setting, whereas in the home-setting, children may have more individual choice concerning ST and parental expectations and norms define the extent of ST [4, 11]. Few preschool interventions have successfully decreased children's ST due to the typical pre-planned and routine-based structures in preschools. Therefore, the allocation of overall children's ST may remain unchanged [12]. Our previous qualitative work among preschool personnel supports this view. Preschool personnel recognized both social situations (e.g., children sit when teachers tell instructions in PA lessons) and structured daily activities (e.g., meal-times, group sessions) in the preschool that require sitting [13]. Similarly, other studies noticed that the regular structures in the preschool setting supports certain appropriate behavior leading to school-type behavior [14-16], although it is also suggested that preschool setting may explain little the variance in children's movement behaviors [17].

In Finland, the day in early childhood education and care services (later used 'preschool' to cover this care) tends to include structured periods of learning, playing, and rest; these structured daily and weekly schedules are followed throughout the year. Child usually attends half (four hours) or full (eight hours) day for preschool. Each 'full' preschool day includes three meal times and usually an afternoon naptime. In aiming to reduce children's ST in Finnish preschool, the in-built daily structure allows two suitable time slots for activities: between breakfast and lunch (morning slot) and between afternoon snack and the end of the day (afternoon slot). The ~~activities~~ program conducted in these slots can be divided either into activities that provide possibility for movement (e.g., free play, outdoor time, PA-related field trips such as nature trips) or non-movement type activities (e.g., sitting-based circles, teacher-led activities requiring sitting). Understanding how these daily or weekly structures influence preschool children's ST may be beneficial in informing research and practitioners in the field. To the best of our knowledge, no such previous studies have been conducted. This information on daily structures in preschool is relevant as Finnish preschool-

aged children are typically only vigorously physically active for approximately 10 percent of each preschool day in Finland, and are physically active at any intensity level for less than 50% of their daily time outdoors [18].

One of the key elements in the Finnish preschool weekly schedule is outdoor time, which is spent either in the preschool's own yard or in conducting trips to nearby facilities that encourage PA. Preschool children tend to be less sedentary during outdoor-time in preschools than indoors, according to recent meta-analyses [1, 19]. However, less information exists on whether all forms of outdoor activities are similarly associated with higher PA and lower ST [20]. A qualitative study observed that children have higher PA levels during preschool time in a natural environment than in a preschool's outdoor play spaces [21]. Dowda et al , however, discovered that higher numbers of field trips were associated with higher moderate-to-vigorous PA levels, although the association was not significant regarding ST [22]. Early educators consider that organizing PA-related field trips is a potentially good method of diminishing children's ST in preschools [23]. These mixed results underline the importance of studying whether all types of outdoor activities in preschool similarly influence children's ST.

The aim of this study is twofold: ~~a)~~ 1) to study the associations between weekly routines in preschool (e.g., times of outdoors, teacher-led sessions, free play) and children's ST and ~~b)~~ 2) to determine the existence of associations between more frequent visits to places encouraging PA (e.g., frequency of visits in nature or gym and field trips to neighborhoods) and children's ST.

METHODS

Study context

Municipalities are responsible for organizing preschool education for children in Finland. All children under school-age have the right to a preschool place for at least 20 hours a week. Preschool children are enrolled in formal childcare for an average of 30 hours or more per week [24]. Preschool care in Finland is subsidized; the maximum monthly fee is €290 (as of 2018). Family income and family size are accounted for in determining the fee. [25]

The Finnish preschool system is based on the learning-by-playing model. Following the current Finnish national early-childhood policy, preschools should offer stimulating physical environments for children's active play and the development of healthy lifestyles, both indoors and outdoors.

Children usually have access to different types of equipment, including both physical activity equipment and sedentary alternatives. In addition, most of the preschools in Finland have access to natural environments and large outdoor play spaces; additionally, preschools commonly conduct trips to nearby areas that encourage PA (such as athletics field and forest) [25].

Study design and population

The DAGIS (Increased Health and Wellbeing in Preschools) study is a long-term project with multiple data collection phases. More detailed information on the whole DAGIS study consortium can be read elsewhere [26, 27]. Part of this project involved conducting a cross-sectional study between autumn 2015 and spring 2016. Municipalities with a larger variety in education and income levels according to national statistics were invited to participate [28]. A total of eight municipalities (of eleven contacted municipalities) were willing to participate in this cross-sectional study. Preschools in these municipalities were randomly invited to participate. The number of invited preschools was based on power and sample size calculations. The main recruitment criterion for the preschools was the existence of at least one preschool group with children aged three to six. Purely pre-primary education groups only for six-year-olds were not included in the study sample. Eighty-six preschools (56% of those invited) gave permission for conducting the study in their preschools. Exclusion from the study concerned sixteen preschools either because their official spoken language was neither Finnish nor Swedish or because they were open 24 hours a day. In addition, we excluded preschools in which less than 30% of the children in one preschool group were willing to participate in the study. Of the consenting preschools, twenty failed to reach the required 30% participation rate. Thus, the study was conducted in sixty-six preschools (39 % of those invited). These preschools had a total of 159 preschool groups (ranging between one to five groups in each preschool) with children aged three to six.

Preschools recruited children and families. A total of 983 parents gave written permission for their child to participate in the study; however, 91 parents had a child in a preschool with less than the 30% participation rate. In addition, 28 children had no data that could be used. Consequently, a total of 864 children participated in the study. The Figure 1 summarises the participation for the DAGIS cross-sectional study. The University of Helsinki Ethical Review Board in the Humanities and Social and Behavioral Sciences approved the study procedures (6/2015, approved in 25th February 2015).

Children's ST was measured using an Actigraph W-GT3X accelerometer (Actigraph, LLC, Fort Walton Beach, Florida). Actigraphs have been validated and extensively used as an objective measure of PA and ST [29-32]. Research assistants set the accelerometer on children's hips on the first day of the measurement. Children wore accelerometer 24 hours for following seven days. Following data collection, the epoch length was set at 15 seconds. Periods of 10 minutes or more at zero accelerometer counts were considered non-wearing times and were excluded. Possible nap-times were not excluded. The analyses involved applying the Evenson ST cut-point (0–25 counts per 15 seconds) [33], a good estimate of free-living ST [34]. Parent-provided information about daily preschool hours were applied to separate the preschool hours from the overall accelerometer data. Only the accelerometer data from the preschool hours were used in this study. We set the following wear-time criteria for this measure: children needed to be at the preschool for at least 240 minutes per day for at least two days. Because preschool-hours varied between children, the final outcome measure was formed so total ST minutes in preschool was divided by the total accelerometer wearing time in preschool and multiplied by 60 to create outcome variable expressed as average minutes per hour (min/h). Thus, the measure used in this study indicates the children's average ST minutes per hour in preschool.

Preschool setting

Weekly programs

Early educators in preschool groups completed a program of their activities during the week that children in their group wore an accelerometer. This program was a semi-structured sheet, with the times of the day listed in rows in the first column and each day (Monday to Friday) separated into its own column. Each day had breakfast, lunch, nap time, and afternoon snack ready-written on the sheet. Educators were asked to write the activities the group had conducted in the empty rows on the time slots between breakfast and lunch (morning slots) and between afternoon snack and the end of the day (afternoon slots) .

This information was recoded into measures as follows. Most of the preschool groups usually conducted two activities in each session (morning/afternoon), therefore, we categorized two activities for the morning session and two for the afternoon session. These activities were categorized into five main groups based on the educators' reported activities. The following five main categories were grouped: 1= outdoors (all activities conducted outside, either in their own yard or on field trips), 2= Teacher-led sessions (all activities that mainly required sitting, and teacher-led activities in the group such as morning circles, craft making and reading circles), 3= free

play (when children played alone or with other children without an adult initiating, facilitating or organizing the play), 4=PA lesson (organized PA lesson either outside or inside, although clearly being a teacher-led, organized lesson), and 5= mixed sessions (the group had conducted multiple different activities in smaller groups and these smaller groups had alternated the activities). We calculated the daily number of each activity. This number was summed up for the week level; we expected to find at least three days with full details of activities. This score was then divided by the number of the days (from three to five) to form the average daily amount of each activity. The measures related to free play, organized PA lessons and mixed activity were skewed with a great number of 'not at all' answers. Thus, these measures were recoded either as categorical or dichotomous. The Table 1 present the more detailed information of each measure.

Questionnaire related to group practices

One early educator in each group completed a questionnaire related to practices and regulations of children's health behaviors in their preschool group. The questionnaire was based on previously used questions and items that had been adjusted for the Finnish preschool context [13, 35, 36]. One of the questions in this questionnaire related to PA possibilities. Firstly, the early educator was asked to report which of the following places encouraging PA are close to the preschool (easy and short walk for children). The questionnaire had a total of nine answer options: nature, play park, neighborhood sport facility, gym (situated outside of preschool), ball court, athletics track, ski tracks, slopes and ice rink. This study uses only the first four options, as these options tend to happen more often and are not dependent on specific seasons (for example, skiing requires snow). In addition, a separate question in the questionnaire asked if the group conducts field trips to neighborhoods and how often.

If an early educator reported 'yes, there is a place nearby', the following questions asked in more detail if it is used (yes/no) and how often. The frequency was measured in a semi-structured way, with options given to the early educator regarding the number of times and selected time frequency: per week/month/year.

These questions were recoded to a suitable timeframe. If an early educator reported that no facility exists nearby, it was recoded to zero. Similarly, if an early educator reported that a facility exists nearby but is not used, it was recoded to zero. Frequencies of visits to these facilities were recoded to times per week. The measured related to visits in neighborhood sports facilities and gym or other indoor facilities had a great number of ' no at all visits', and thus were treated as dichotomous in the analyses. Table 1 indicates the used form of measure.

Table 1. Descriptives of preschool group practices used in the DAGIS study

Preschool group practices		Descriptive	Descriptive	N (number of preschool groups)
Weekly structures				
Times of outdoor time		Mean 2.45 times per day	Standard deviation 0.69	96
Times of teacher led sessions		Mean 0.76 times per day	Standard deviation 0.67	96
Times of free play	Low (not at all)	44.8%	n=43 preschool groups	96
	Middle (between 0.1 to 0.8 times per day)	31.3%	n=30 preschool groups	
	High (between 0.81 to 4 times per day)	24.0%	n=23 preschool groups	
Times of organized PA lessons	No lessons at all	56%	n=54 preschool groups	96
	Others	44%	n=42 preschool groups	
Times of mixed activity	No mixed sessions	71%	n=68 preschool groups	96
	Others	29%	n=28 preschool groups	
Frequency of visits to places encouraging PA				
Frequency of nature trips		Mean 0.93 times per week	Standard deviation 0.62	138
Frequency of visits to play parks		Mean .41 times per week	Standard deviation 0.72	139
Frequency of visits to neighborhood sport facilities	No visits at all	62%	n=85 preschool groups	137
	Others	38%	n=52 preschool groups	
Frequency of visits to gym or other indoor facility (which is not own)	No visits at all	57%	n=82 preschool groups	143
	Others	43%	n=61 preschool groups	
Frequency of field trips to neighborhoods		Mean .52 times per week	Standard deviation 0.56	134

Covariates

The analyses' covariates were children's age, gender, average attendance at preschool and study season. Children's attendance at preschool was a composite score of the answers of their guardian's questionnaire: How many days per week does your child attend preschool? and how many hours per day does your child usually attend preschool? Combining these items enabled illustrating children's attendance at preschool regarding their daily average hours in preschool (hours/day). The study

season measure was divided into three categories: 1=September–October, 2= November–December, and 3=January–April.

Statistical analyses

The descriptive statistics were checked using the SPSS statistical program version 24 (SPSS Inc.,Chicago, IL, USA), whereas the multilevel linear regression models were run using the Mplus program version 7.14 (Muthen & Muthen,2018). All analyses were adjusted for each child's age and gender, average preschool hours, and measurement season; analysis concerned the individual associations of each preschool group practice. The most appropriate statistical method uses multilevel models when focusing on group-level effects and their association with individual-level variables in data sets involving persons nested in groups, such as children attending the same preschool group. In the analyses, children were designated as the first-level unit, and preschool groups as the second-level unit [37]. Each individual-level independent variable (child's age and gender, average preschool hours) was group-mean centered [38]; the estimator in the analyses was MLR (maximum likelihood with robust standard errors).

RESULTS

Of the 864 participating children, 48% were girls, the average age of participants was 4.7 years (standard deviation 0.89) and the children spent on average 34.6 hours per week in preschool (standard deviation 8.8). Of these participating children, a total of 821 children (95% of the participants) had some accelerometer data to use in forming the variables, and of them, 778 had the required amount of accelerometer data for preschool hours. The average ST measured in the preschool by accelerometers was 26.47 minutes per hour (standard deviation 5.10 minutes).

Of the 159 possible groups (82% response rate), a total of 131 preschool groups completed the weekly programs. Of this total number, 96 groups had complete information on their activities from at least three days (73% of the possible programs). In addition, 146 of early educators returned the preschool group questionnaire (92% response rate). On average, the preschool groups had six nearby PA facilities out of nine possible measured facilities (standard deviation 1.9). Collected in early autumn (September – October) was approximately 44% of the data (n=379 children); collected in late autumn (November – December) was 36% of the data (n=310 children); collected in spring (January – April) was 20% of the data (n=175 children). The Spearman correlations between explonatory factors and children's ST can be found in the supplementary Table 1.

Table 2 presents the results of our multilevel linear regression analyses to study the assocations between weekly routines in preschool or more frequent visits to places encouraging for PA, and children's ST. Out of ten studied associations, only the more frequently conducted nature trips were associated with children's lower ST. No other significant associations were found between preschool group practices and children's ST.

Table 2. The associations of preschool group practices and children's sedentary time (min/h) in multilevel linear regression models

			β	Lower 95%CI	Upper 95% CI	p-value	N
Preschool group practices							
	Times of outdoor time		-0.259	-1.293	0.776	0.624	470
	Times of teacher-led sessions		0.438	-0.797	1.672	0.487	470
	Times of free play [1]	Low	-0.655	-2.626	1.316	0.515	470
		Middle	-1.206	-3.312	0.901	0.262	
		High (reference)					
	Times of organized PA lessons [2]		0.661	-0.730	2.052	0.352	470
	Times of mixed activity[3]		-0.635	-1.768	0.497	0.272	470
Frequency of visits to places encouraging PA							
	Frequency of nature trips		-1.026	-1.804	-0.248	0.010	655
	Frequency of visits to play parks		0.264	-0.278	0.806	0.340	649
	Frequency of visits to neighborhood sport facilities [4]		-0.520	-1.558	0.519	0.327	654
	Frequency of visits to gym or other indoor facility [5]		0.184	-0.913	1.281	0.742	671
	Frequency of field trips to neighborhoods		0.040	-0.909	0.989	0.934	647

All the analyses are adjusted for children's age, gender and average preschool attendance and measurement season.

[1] treated as categorized.

[2] treated as dichotomous; no lessons at all (0) and others (1).

[3] treated as dichotomous; no mixed lessons (0) and others (1).

[4] treated as dichotomous; no visits at all (0) and others (1).

[5] treated as dichotomous; no visits at all (0) and others (1).

DISCUSSION

This study aimed to determine both the associations between weekly routines in preschool and children's ST and the existence of associations between more frequent visits to places that encourage PA and children's ST. Of all the tested associations, we identified associations between more frequently conducted nature trips and lower children's ST.

Associated with lower children's ST was more frequently conducted nature trips in preschool, the only significantly associated factor identified in our study. Other studies have also highlighted that playing in natural environments not only increases children's PA levels, but also positively affects children's health, wellness, learning and development, making it a valuable habit to learn in early childhood [39-41]. Potential explanation for children's lower ST levels in nature is that nature challenges all children in different ways, compared to the preschool setting with built outdoor yards. Nature does not offer direct environmental cues for sitting, rather nature offers possibilities for open movement and flexibility. Children who regularly attend preschool may get bored with the same daily alternatives for playing in the preschool yard and PA opportunities in a yard may be less challenging; nature, however, challenges children's imagination differently and diversely [42]. Fixed playground equipment often involve closed or fixed ways of moving and can encourage more sedentary-type activities (e.g., sandboxes and swings are typical equipment in a yard). Therefore, nature may be especially important for children who tend to play more passively in playgrounds [21]. Nature seems to encourage all children, despite their age, size or other personal characteristics, to get involved in creativity and spontaneous exploration; thus all children may easily discover their own type of active play [21, 43, 44]. Consequently, developing public health strategies that increase nature visits at an early age is relevant. Additionally important is determining whether all kinds of outdoor activities play a similar role in children's movement behaviors. Measuring the length of outdoor activities in each preschool group was impossible in our study; this may be a relevant factor, however. Children may have short intense bouts of activity, lasting less than 15 minutes, at the start of outdoor free-play periods in a preschool yard following extended periods of ST. Breaking outdoor times into shorter periods of time may be more beneficial [19, 45, 46].

Our study examined the associations between multiple weekly or daily structures and children's ST during the same measurement week. However, none of the measured weekly practices were significantly associated with children's ST. Other studies have found similar results [15, 17, 47]. A comparative study between preschools in the USA and Sweden found differences in daily routines and the supervision of children's behaviors at preschools. In the USA, rules, routines and adult

leadership caused children to interrupt their ongoing activity, and many of the everyday routines were associated with children either being instructed or encouraged to stay inactive. However, Swedish preschools had shorter periods of mandatory or encouraged SB periods, with mainly one to two daily teacher-led sessions involving all children, during which they sit in a circle on the floor and were expected to stay calm [15]. In the UK, Hesketh et al. discovered the limited influence of preschool environment on children's movement behaviors, with children's individual activity preferences playing a bigger role [17] . To summarize these comparisons with the results of our study, a less structured preschool day may result in the preschool environment exerting a smaller influence on children's movement behaviors. Therefore, differences in children's ST concern other factors, for example, children's individual characteristics. Overall, these different findings between studies highlight sociocultural differences between countries, which should be better accounted for when developing methods to measure factors associated with children's ST in preschool settings.

We did not measure the actual content of each these measured daily structures. For instance, we do not know what children actually did when they were outside or had free-play sessions. During the free-play sessions and outdoor time, children can usually choose from a range of multiple options, from sedentary alternatives to more PA-related equipment. Previous studies have indicated that children's individual characteristics, for instance gender and temperament, are associated with children's ST in preschool [1, 48, 49]. Consequently, early educators may have little control over the type of activity a child partakes in during free-play or outside sessions, as children's individual characteristics may play a bigger role. Notably, children self-select their own activities daily, meaning that one day they may choose more sedentary activities, whereas another day, more physical activities [17]. Studies have shown that children spend less than 50% of time in PA during free-play periods, suggesting that adding structure to these periods may increase the amount of PA [12, 50, 51]. Structure could involve providing equipment for children with instructions on how to use the equipment, or teachers' prompts, encouragement or playing together with children [12, 51]. Interestingly, children with low levels of PA may benefit from this structured-type of free play, whereas the most active children often benefit more from having less structure [51]. Thus, each child needs to learn to sit still and develop their cognitive and self-regulation skills during their preschool years, but more essential is discovering how to break children's ST and find optimally short bouts of ST during preschool hours. Therefore, studying the role of children's individual characteristics may be necessary in explaining children's ST.

Early educators play an important role in determining ST and PA; however, socially relevant is the

other children in the preschool group and their influence on children's behavior. Over time, children's PA and dietary intake tend to become similar to their peers' levels in a preschool group [52]; children's PA levels are often higher in the presence of peers [53]. A recent study observed that the most active children tend to seek other physically active children, whereas children who are introverted or who may not have close friendships with their peers may feel uncomfortable or excluded and revert to low- intensity physical activities [51]. Teacher-led sessions are usually pre-planned, with guided participation of children; all the children in a group usually conduct similar activities, allowing less freedom for children's individual choice of activities [14]. However, other studies support teacher-led activities, claiming they increase children's movement and activity levels compared to free-play sessions [48, 54, 55]. Therefore, essential is determining the most effective type of social influence, adult-initiated or child-initiated, in decreasing children's ST. For instance, children with particular temperament traits may benefit more from adults' than peers' role modelling.

Our study introduced novel knowledge by studying the organizational factors associated with children's ST; this is essential information according to a recent review[56]. An additional strength of our study concerns the information collected from the preschool groups regarding time-stamped weekly practices during the week when children wore an accelerometer. We measured the associations between multiple places encouraging for PA and children's ST instead of measuring total outdoor time or combined indicators of activities. The novelty of this study concerns the information provided on whether all types of PA places similarly decrease children's ST. The random selection technique enabled our study sample to cover large and small preschools situated in both urban and countryside environments in different municipalities. Therefore, our sample widely represents activities conducted in Finnish preschools, simultaneously preventing a limited focus on certain areas (e.g., urban). However, our study had some shortcomings. We did not receive weekly programs from all the participating groups and the drop-out rate (40%) was quite high; we cannot estimate the reasons for this non-response. We could not measure the actual length (in minutes or hours) of the weekly practices to allow measuring whether differences existed in the lengths of activities between preschools. In addition, categorisation of the explanatory factors may influence in the results we found. Due to limited sample size, we were not able to make sensitivity analyses (e.g. testing potential interaction effect of gender and age). Although accelerometers are commonly used and can measure children's movement behaviors in free-living conditions, notably, accelerometers cannot always distinguish between sitting and standing. Additionally, differently used cut-points and data reduction methods may influence the dissimilarity in the results of

different studies. The nap times were not separated from the accelerometer data, which may overestimate the time spent in SB. The cross-sectionality of this data does not allow drawing conclusions on the causality of the studied associations. We found only one statistically significant associations out of all the tested associations in our analyses. It may be that the increased number of statistical tests performed increased the potential for type 1 error. In addition, our effect sizes were small. However, these results may have practical importance when developing the effective interventions aiming to reduce children's ST. Important to notice is the existence of multiple unexplored social- and individual factors that may affect children's preschool behavior at this age, requiring further investigation with high quality and reliable measures.

CONCLUSION

This study assessed whether preschool weekly routines are associated with children's ST, and whether more frequent visits to places encouraging PA are associated with children's ST. Of the tested associations, more frequently conducted nature trips were associated with lower children's ST. Nature may challenge children to use their creativity in various activities, and also encourages all children to walk and take steps in different ways than in the more-structured type of places that encourage PA. Based on our study, routines and structures in the preschool setting have little influence on children's ST. Future studies could determine whether other factors, for instance children's individual characteristics, play a bigger role in explaining children's ST.

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Ethics approval: the University of Helsinki Review Board in the Humanities and Social and Behavioral Sciences

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Data sharing statement: Researchers interested in the data from this study may contact principal investigator Eva Roos, eva.roos@folkhalsan.fi.

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Figure 1. The flow chart of participation in the DAGIS cross-sectional study.

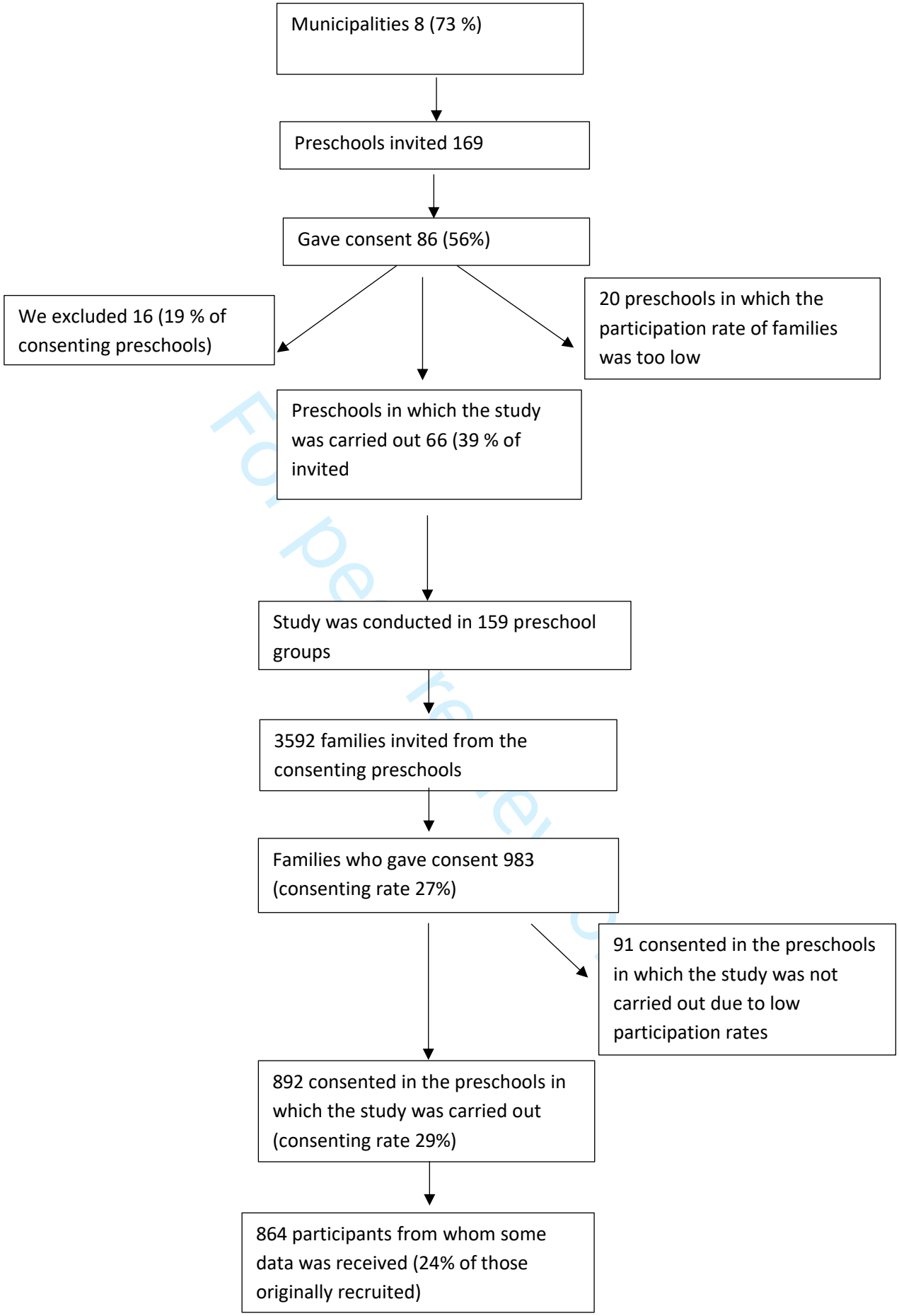


Figure 1. The flow chart of participation in the DAGIS cross-sectional study.

Supplementary Table 1. Spearman correlations between the measures used in the study (listwise N=757)

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Children's sedentary time in preschool (min/hour)										
2. Times of outdoor time	-0.060									
3. Times of teacher-led sessions	0.078	-0.335***								
4. Times of free play	-0.006	-0.258***	-0.243***							
5. Times of organized PA lessons	0.120**	-0.159***	0.097*	-0.033						
6. Times of mixed activity	0.762	-0.166***	-0.290***	-0.063	0.058					
7. Frequency of nature trips	0.042	0.041	-0.112**	0.038	-0.084	0.017				
8. Frequency of visits to play parks	0.089	0.019	0.000	-0.097*	0.054	0.045	0.133***			
9. Frequency of visits to neighborhood sport facilities	-0.010	-0.315***	0.039	-0.057	0.069	0.176***	0.092*	0.207***		
10. Frequency of visits to gym or other indoor facility	-0.015	-0.029	0.678	-0.196***	0.027	-0.034	-0.015	0.105**	0.235***	
11. Frequency of field trips to neighborhoods	0.032	-0.096*	0.237***	-0.091*	-0.011	0.108*	0.237***	0.198***	0.160***	0.040

*p<0.05, **p<0.01, ***p<0.001

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1	Preschool group practices and preschool children's sedentary time: a cross-sectional study in Finland
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2	abstract
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4	Introduction
Objectives	3	State specific objectives, including any prespecified hypotheses	5	The aim of this study is twofold: a) to study the associations between weekly routines in preschool (e.g., times of outdoors, teacher-led sessions, free play) and children's ST and b) to determine the existence of associations between more frequent visits to places encouraging PA (e.g., frequency of visits in nature or gym and field trips to neighborhoods) and children's ST.
Methods				
Study design	4	Present key elements of study design early in the paper	6	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7	a cross-sectional study was conducted between

				autumn 2015 and spring 2016….
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection participants	6-7	A total of 983 parents (27% of contacted parents) gave written permission for their child to participate in the study
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8	Indicators of sedentary behaviors Children wore an Actigraph W-GT3X accelerometer…
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6-8*	Research assistant attached accelerometer to the child's waist in the preschool.
Bias	9	Describe any efforts to address potential sources of bias	6	A major recruitment criterion was that there had to be at least one group of children aged 3-6 in the preschool. Eighty-six heads of preschools (56% participation rate) gave their written consent for participation in the study.
Study size	10	Explain how the study size was arrived at	9	Of these participating children, a total of 821 children (95% of the participants) had some accelerometer data to use in forming the variables,

	and of them, 778 had the required amount of accelerometer data for preschool hours.

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8	Early educators in preschool groups completed a program of their activities during the week that children in their group wore an accelerometer
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7	The analyses were adjusted the child's age and gender…
		(*b*) Describe any methods used to examine subgroups and interactions	7-8	Due to limited sample size, we were not able to make sensitivity analyses
		(*c*) Explain how missing data were addressed		
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	7	The non-independence of observations due to cluster sampling (children in the preschool groups) was taken into account in the analyses,
		(*e*) Describe any sensitivity analyses	7-8	Due to limited sample size, we were not able to make sensitivity analyses
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9	Of the 864 participating children, 48% were girls, the average age of participants was 4.7 years (standard deviation 0.89) and the children spent on average 34.6 hours per week in preschool (standard deviation 8.8).
		(b) Give reasons for non-participation at each stage	Figure 1 and page 15	we cannot estimate the reasons for this non-response.
		(c) Consider use of a flow diagram	Figure 1	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9	Table 1 and result section

		(b) Indicate number of participants with missing data for each variable of interest	Table 1, Table	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposu		
		Cross-sectional study—Report numbers of outcome events or summary measures	?	Results section
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	, plus supplementary Table 1 with correlations	The analyses were adjusted for municipality, the child's age and gender, and the season during which the accelerometer was used…
		(*b*) Report category boundaries when continuous variables were categorized	Table 1	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		

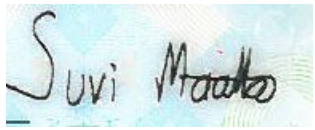
Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	supplementary file	
Discussion				
Key results	18	Summarise key results with reference to study objectives	10	This study aimed to
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-13	
Generalisability	21	Discuss the generalisability (external validity) of the study results	13	that it encompasses a large sample, including children from 66 different preschools in various municipalities
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13	This study was financially supported

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

ON THE BEHALF OF THE AUTHORS,



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Preschool group practices and preschool children's sedentary time: a cross-sectional study in Finland

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Preschool group practices and preschool children's sedentary time: a cross-sectional study in Finland

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Abstract

objectives: Preschool is an important setting for regulating sedentary time (ST). The preschool day in Finland follows daily structures by having morning and afternoon slots for group-based activities that can encourage children for movement (e.g., free play, outdoor time) or be still (e.g., teacher-led sessions, sitting-based circles). This study aims to explore if the weekly routines in preschool, and if more frequent visits in places encouraging physical activity (PA) are associated with children's ST during preschool hours.

design: Cross-sectional DAGIS (Increased Health and Wellbeing in Preschools) study in years 2015 and 2016.

setting: In Finland

participants: 864 children (48% girls, 4.7 years) from 159 preschool groups in 66 preschools

outcome measures: A total of 778 children wore required lengths of time (at least 240 minutes per preschool day, at least two days) the accelerometer during preschool hours. Each preschool group reported their weekly schedule during the week, and one early educator completed questionnaire covering practices. The following five measures related to weekly structures were formed; times of outdoors (times per day), teacher led sessions (times per day), free play (low, middle or high), organized PA lessons (no lessons at all/others) and mixed activities (no lessons at all/others), and the following five measures about the frequencies of visits in places encouraging PA; nature trips (times per week), play parks (times per week), neighborhood sport facilities (no visits at all/others), visits to gym or other indoor facility (no visits at all/others) and field trips to neighborhoods (times per week). Multilevel linear regression analyses were conducted to measure the associations.

results: Of all the tested associations, only more frequently conducted nature trips were associated with lower children's ST during preschool hours (β=-1.026; 95% CI: -1.804, -0.248).

conclusions: Frequent nature trips in preschools may be important due to its association with lower preschool children's ST.

Keywords: sedentary lifestyle, preschool, children, physical activity

An Article Summary

Strengths and limitations of this study:

- The major strength is that we have measured the associations between multiple places encouraging for PA and children's ST instead of measuring total outdoor time or combined indicators of activities

- Another strength is that we have the information collected from the preschool groups regarding time-stamped weekly practices during the week when children have worn an accelerometer.
- The limitation is that the hip-worn accelerometer may not effectively separate standing from sitting and reclining positions.
- Another limitation is that we did not receive weekly programs from all the participating groups (the drop-out rate is 40%).

INTRODUCTION

Preschool-aged children, roughly three to five years, are commonly assumed as being inherently active, moving throughout the day mainly in random and intermittent ways (e.g., unstructured active play). However, contrary to expectations, a recent meta-analysis states that preschool-aged children spend approximately 50% of their waking hours in sedentary behavior [1]. Sedentary behavior (SB) is defined as any waking behavior characterized by an energy expenditure less than or equal to 1.5 metabolic equivalents (METs) while in a sitting, reclining or lying posture, whereas sedentary time (ST) is defined as the time spent in sedentary behaviors [2]. Every child needs to engage in some SB every day; however, promoting SB habits in short bouts and limiting prolonged ST may be important for the primary prevention of obesity [3, 4]. Like many other health behavior habits, SB habits tend to track from early childhood to later in life, thus predicting future health behaviors [5]. The preschool-age period may therefore serve as an ideal timeframe for minimizing ST and promoting more active movement behaviors such as active play and physical activity (PA).

It is widely encouraged to recognize better the setting-specific correlates of children's ST [6]. Alongside home, the early childhood education and care setting such as preschool plays an important role in shaping children's behavior. This role is due to the preschool setting being where most children of this age group spend the majority of their waking hours. In Finland, for instance, approximately 80% of children aged three to five with different socioeconomic backgrounds attend preschool in approximately similar rates to other OECD countries [7]. According to a recent review, which was based on 55 studies conducted in preschool-type settings, children's ST ranged between 12 minutes and 55 minutes per hour in preschool [8]. Another review stated that the proportion of time spent in overall ST (despite the context) ranged from 34% to 94% between studies [9]. Children in preschool may also be more sedentary than children cared for at home, although

opposite results have also been found [1, 8]. The variation in these results stresses the significance of understanding which factors are associated with preschool children's ST in the preschool setting.

Following the socioecological model of SB, a setting is the physical and social context where ST occurs [10]. ST in different behavior settings has likely distinct correlates because both the attributes of the setting and the social frame around this setting shape behavior [10, 11]. For instance, home and preschool are different types of settings regarding how much ST in these settings involves individual choice and how much contains environmental and social constraints. According to this viewpoint, multiple social constraints, norms and structures concerning expectations of sitting (e.g., morning circles, group-activities) may encourage ST in the preschool setting, whereas in the home-setting, children may have more individual choice concerning ST and parental expectations and norms define the extent of ST. [4, 11] Few preschool interventions have successfully decreased children's ST due to the typical pre-planned and routine-based structures in preschools. Therefore, the allocation of overall children's ST may remain unchanged. [12] Our previous qualitative work among preschool personnel supports this view. Preschool personnel recognized both social situations (e.g., children sit when teachers tell instructions in PA lessons) and structured daily activities (e.g., meal-times, group sessions) in the preschool that required sitting [13]. Similarly, other studies have noticed that the regular structures in the preschool setting supports certain appropriate behavior leading to school-type behavior [14-16], although it is also suggested that preschool setting may explain little the variance in children's movement behaviors [17].

In Finland, the day in early childhood education and care services (later used 'preschool' to cover this care) tends to include the structured periods of learning, playing, and rest; these structured daily and weekly schedules are followed throughout the year. Child usually attends half (four hours) or full (eight hours) day for preschool. Each 'full' preschool day includes three meal times and usually an afternoon naptime. In aiming to reduce children's ST in Finnish preschool, the in-built daily structure allows two suitable time slots for activities: between breakfast and lunch (morning slot) and between afternoon snack and the end of the day (afternoon slot). The program conducted in these slots can be divided either into activities that provide possibility for movement (e.g., free play, outdoor time, PA-related field trips such as nature trips) or non-movement type activities (e.g., sitting-based circles, teacher-led activities requiring sitting). Understanding how these daily or weekly structures influence preschool children's ST may be beneficial in informing research and practitioners in the field. To the best of our knowledge, no such previous studies have been

conducted. This information on daily structures in preschool is relevant as Finnish preschool-aged children are typically only vigorously physically active for approximately 10 percent of each preschool day in Finland, and are physically active at any intensity level for less than 50% of their daily time outdoors [18].

One of the key elements in the Finnish preschool weekly schedule is outdoor time, which is spent either in the preschool's own yard or in conducting trips to nearby facilities that encourage PA. Preschool children tend to be less sedentary during outdoor-time in preschools than indoors, according to recent meta-analyses [1, 19]. However, less information exists on whether all forms of outdoor activities are similarly associated with higher PA and lower ST [20]. A qualitative study observed that children had higher PA levels during preschool time in a natural environment than in outdoor play spaces [21]. Dowda et al , however, discovered that higher numbers of field trips were associated with higher moderate-to-vigorous PA levels, although the association was not significant regarding ST [22]. Early educators consider that organizing PA-related field trips is a potentially good method of diminishing children's ST in preschools [23]. These mixed results underline the importance of studying whether all types of outdoor activities in preschool similarly influence children's ST.

The aim of this study is twofold: 1) to study the associations between weekly routines in preschool (e.g., times of outdoors, teacher-led sessions, free play) and children's ST and 2) to determine the existence of associations between more frequent visits to places encouraging PA (e.g., frequency of visits in nature or gym and field trips to neighborhoods) and children's ST.

METHODS

Study context

Municipalities are responsible for organizing preschool education for children in Finland. All children under school-age have the right to a preschool place for at least 20 hours a week. As the school starts at the age of seven, the children attending to preschool are usually aged one to six years. Preschool children are enrolled in formal childcare for an average of 30 hours or more per week. [24] Preschool care in Finland is subsidized; the maximum monthly fee is €290 (as of 2018). Family income and family size are accounted for in determining the fee. [25]

The Finnish preschool system is based on the learning-by-playing model. Following the current Finnish national early-childhood policy, preschools should offer stimulating physical environments for children's active play and the development of healthy lifestyles, both indoors and outdoors. Children usually have access to different types of equipment, including both PA equipment and sedentary alternatives. In addition, most of the preschools in Finland have access to natural environments and large outdoor play spaces; additionally, preschools commonly conduct trips to nearby areas that encourage PA (such as athletics field and forest). [25]

Study design and population

The DAGIS (Increased Health and Wellbeing in Preschools) study is a long-term project with multiple data collection phases. More detailed information on the whole DAGIS study consortium can be read elsewhere [26, 27]. Part of this project involved conducting a cross-sectional study between autumn 2015 and spring 2016. Municipalities with a larger variety in education and income levels according to national statistics were invited to participate [28]. A total of eight municipalities (of eleven contacted municipalities) were willing to participate in this cross-sectional study. Preschools in these municipalities were randomly invited to participate. The number of invited preschools was based on power and sample size calculations. The main recruitment criterion for the preschools was the existence of at least one preschool group with children aged three to six. Purely pre-primary education groups only for six-year-olds were not included in the study sample. Eighty-six preschools (56% of those invited) gave permission for conducting the study in their preschools. Exclusion from the study concerned sixteen preschools either because their official spoken language was neither Finnish nor Swedish or because they were open 24 hours a day. In addition, we excluded preschools in which less than 30% of the children in one preschool group were willing to participate in the study. Of the consenting preschools, twenty failed to reach the required 30% participation rate. Thus, the study was conducted in sixty-six preschools (39 % of those invited). These preschools had a total of 159 preschool groups (ranging between one to five groups in each preschool) with children aged three to six.

Preschools recruited children and families. A total of 983 parents gave written permission for their child to participate in the study; however, 91 parents had a child in a preschool with less than the 30% participation rate. In addition, 28 children had no data that could be used. Consequently, a total of 864 children participated in the study. A parent or legal guardian of each participating child

provided an informed consent. The University of Helsinki Ethical Review Board in the Humanities and Social and Behavioral Sciences approved the study procedures (6/2015, approved in 25th February 2015). The Figure 1 summarizes the participation for the DAGIS cross-sectional study.

MEASURES

Children's sedentary time

Children's ST was measured using an Actigraph W-GT3X accelerometer (Actigraph, LLC, Fort Walton Beach, Florida). Actigraphs have been validated and extensively used as an objective measure of PA and ST [29-32]. Research assistants set the accelerometer on children's hips on the first day of the measurement. Children wore accelerometer 24 hours for following seven days. Following data collection, the epoch length was set at 15 seconds. Periods of 10 minutes or more at zero accelerometer counts were considered non-wearing times and were excluded. Possible nap-times were not excluded. The analyses involved applying the Evenson ST cut-point (0–25 counts per 15 seconds) [33], a good estimate of free-living ST [34]. Parent-provided information about the daily preschool hours were applied to separate the preschool hours from the overall accelerometer data. Only the accelerometer data from the preschool hours were used in this study. We set the following wear-time criteria for this measure: children needed to be at the preschool for at least 240 minutes per day for at least two days. Because preschool hours varied between children, the final outcome measure was formed so total ST minutes in preschool was divided by the total accelerometer wearing time in preschool and multiplied by 60 to create outcome variable expressed as average minutes per hour (min/h). Thus, the measure used in this study indicates the children's average ST minutes per hour in preschool.

Preschool setting

Weekly programs

Early educators in preschool groups completed a program of their activities during the week that children in their group wore an accelerometer. This program was a semi-structured sheet, with the times of the day listed in rows in the first column and each day (Monday to Friday) separated into its own column. Each day had breakfast, lunch, nap time, and afternoon snack ready-written on the sheet. Educators were asked to write the activities the group had conducted in the empty rows on the time slots between breakfast and lunch (morning slots) and between afternoon snack and the end of the day (afternoon slots).

This information was recoded into measures as follows. Most of the preschool groups conducted two activities in each session (morning/afternoon). Therefore, we classified two activities for the morning session and two for the afternoon session. These activities were categorized into five main groups based on the educators' reported activities. The following five main categories were grouped: 1= outdoors (all activities conducted outside, either in their own yard or on field trips), 2= Teacher-led sessions (all activities that mainly required sitting, and teacher-led activities in the group such as morning circles, craft making and reading circles), 3= free play (when children played alone or with other children without an adult initiating, facilitating or organizing the play), 4= organized PA lessons (organized PA lesson either outside or inside, although clearly being a teacher-led, organized lesson), and 5= mixed sessions (the group had conducted multiple different activities in smaller groups and these smaller groups had alternated the activities). We calculated the daily number of each activity. This number was summed up for the week level. We expected to find at least three days with full details of activities. This score was then divided by the number of the days (from three to five) to form the average daily amount of each activity. The measures related to free play, organized PA lessons and mixed activity were skewed with a great number of 'not at all' answers. Thus, these measures were recoded either as categorical or dichotomous. The Table 1 present the more detailed information of each measure.

Questionnaire related to group practices

One early educator in each group completed a questionnaire related to practices and regulations of children's health behaviors in their preschool group. The questionnaire was based on previously used questions and items that had been adjusted for the Finnish preschool context [13, 35, 36]. One of the questions in this questionnaire was related to PA possibilities. Firstly, the early educator was asked to report which of the following places encouraging PA were close to the preschool (easy and short walk for children). This question had a total of nine answer options: nature, play park, neighborhood sport facility, gym (situated outside of preschool), ball court, athletics track, ski tracks, slopes and ice rink. This study uses only the first four options, as these options tend to happen more often and are not dependent on specific seasons (for example, skiing requires snow). In addition, a separate question in the questionnaire asked if the group conducted field trips to neighborhoods and how often.

If an early educator reported 'yes, there is a place nearby', the following questions asked more in detail if it is used (yes/no) and how often. The frequency was measured in a semi-structured way, with options given to the early educator regarding the number of times and selected time frequency: per week/month/year.

These questions were recoded to a suitable timeframe. If an early educator reported that no facility exists nearby, it was recoded to zero. Similarly, if an early educator reported that a facility existed nearby but was not used, it was recoded to zero. Frequencies of visits to these facilities were recoded to times per week. The measured related to visits in neighborhood sports facilities and gym or other indoor facilities had a great number of ' no at all visits', and thus were treated as dichotomous in the analyses. Table 1 indicates the used form of measure.

Table 1. Descriptives of preschool group practices used in the DAGIS study

Preschool group practices		Descriptive	Descriptive	N (number of preschool groups)
Weekly structures				
Times of outdoors		Mean 2.45 times per day	Standard deviation 0.69	96
Times of teacher led sessions		Mean 0.76 times per day	Standard deviation 0.67	96
Times of free play	Low (not at all)	44.8%	n=43 preschool groups	96
	Middle (between 0.1 to 0.8 times per day)	31.3%	n=30 preschool groups	
	High (between 0.81 to 4 times per day)	24.0%	n=23 preschool groups	
Times of organized PA lessons	No lessons at all	56%	n=54 preschool groups	96
	Others	44%	n=42 preschool groups	
Times of mixed activity	No mixed sessions	71%	n=68 preschool groups	96
	Others	29%	n=28 preschool groups	
Frequency of visits to places encouraging PA				
Frequency of nature trips		Mean 0.93 times per week	Standard deviation 0.62	138
Frequency of visits to play parks		Mean .41 times per week	Standard deviation 0.72	139
Frequency of visits to neighborhood sport facilities	No visits at all	62%	n=85 preschool groups	137
	Others	38%	n=52 preschool groups	
Frequency of visits to gym or other indoor facility (which is not own)	No visits at all	57%	n=82 preschool groups	143
	Others	43%	n=61 preschool groups	
Frequency of field trips to neighborhoods		Mean .52 times per week	Standard deviation 0.56	134

Covariates

The analyses' covariates were children's age, gender, average attendance at preschool and study season. Children's attendance at preschool was a composite score of the answers of their guardian's questionnaire: How many days per week does your child attend preschool? and how many hours per day does your child usually attend preschool? Combining these items enabled illustrating children's attendance at preschool regarding their daily average hours in preschool (hours/day). The study season measure was divided into three categories: 1=September–October, 2= November–December, and 3=January–April.

Statistical analyses

The descriptive statistics were checked using the SPSS statistical program version 24 (SPSS Inc.,Chicago, IL, USA), whereas the multilevel linear regression models were run using the Mplus program version 7.14 (Muthen & Muthen,2018). All the analyses were adjusted for each child's age and gender, average preschool hours, and measurement season; analysis concerned the individual associations of each preschool group practice. The most appropriate statistical method uses multilevel models when focusing on group-level effects and their association with individual-level variables in data sets involving persons nested in groups, such as children attending the same preschool group. In the analyses, children are designated as the first-level unit, and preschool groups as the second-level unit [37]. Each individual-level independent variable (child's age and gender, average preschool hours) was group-mean centered [38]; the estimator in the analyses was MLR (maximum likelihood with robust standard errors).

RESULTS

Of the 864 participating children, 48% were girls, the average age of participants was 4.7 years (standard deviation 0.89) and the children spent on average 34.6 hours per week in preschool (standard deviation 8.8). Of these participating children, a total of 821 children (95% of the participants) had some accelerometer data to use in forming the variables, and of them, 778 had the required amount of accelerometer data for preschool hours. The average ST measured in the preschool by accelerometers was 26.47 minutes per hour (standard deviation 5.10 minutes).

Of the 159 possible groups (82% response rate), a total of 131 preschool groups completed the weekly programs. Of this total number, 96 groups had complete information on their activities from at least three days (73% of the possible programs). In addition, 146 of early educators returned the preschool group questionnaire (92% response rate). On average, the preschool groups had six

nearby PA facilities out of nine possible measured facilities (standard deviation 1.9). Collected in early autumn (September – October) was approximately 44% of the data (n=379 children); collected in late autumn (November – December) was 36% of the data (n=310 children); collected in spring (January – April) was 20% of the data (n=175 children). The Spearman correlations between explonatory factors and children's ST can be found in the supplementary Table 1.

Table 2 presents the results of the multilevel linear regression analyses to study the assocations between weekly routines in preschool or more frequent visits to places encouraging for PA, and children's ST. Out of ten studied associations, only the more frequently conducted nature trips were associated with children's lower ST. No other significant associations were found between preschool group practices and children's ST.

Table 2. The associations of preschool group practices and children's sedentary time (min/h) in multilevel linear regression models

			β	Lower 95%CI	Upper 95% CI	p-value	N
Preschool group practices							
	Times of outdoors		-0.259	-1.293	0.776	0.624	470
	Times of teacher-led sessions		0.438	-0.797	1.672	0.487	470
	Times of free play [1]	Low	-0.655	-2.626	1.316	0.515	470
		Middle	-1.206	-3.312	0.901	0.262	
		High (reference)					
	Times of organized PA lessons [2]		0.661	-0.730	2.052	0.352	470
	Times of mixed activity[3]		-0.635	-1.768	0.497	0.272	470
Frequency of visits to places encouraging PA							
	Frequency of nature trips		-1.026	-1.804	-0.248	0.010	655
	Frequency of visits to play parks		0.264	-0.278	0.806	0.340	649
	Frequency of visits to neighborhood sport facilities [4]		-0.520	-1.558	0.519	0.327	654
	Frequency of visits to gym or other indoor facility [5]		0.184	-0.913	1.281	0.742	671
	Frequency of field trips to neighborhoods		0.040	-0.909	0.989	0.934	647

All the analyses were adjusted for children's age, gender and average preschool attendance and measurement season.

[1] treated as categorized.

[2] treated as dichotomous; no lessons at all (0) and others (1).

[3] treated as dichotomous; no mixed lessons (0) and others (1).
[4] treated as dichotomous; no visits at all (0) and others (1).
[5] treated as dichotomous; no visits at all (0) and others (1).

DISCUSSION

This study aimed to determine both the associations between weekly routines in preschool and children's ST and the existence of associations between more frequent visits to places that encourage PA and children's ST. Of all the tested associations, we identified associations between more frequently conducted nature trips and lower children's ST.

Associated with lower children's ST was more frequently conducted nature trips in preschool. Other studies have also highlighted that playing in natural environments not only increases children's PA levels, but also positively affects children's health, wellness, learning and development, making it a valuable habit to learn in early childhood [39-41]. Potential explanation for children's lower ST levels in nature is that nature challenges all children in different ways, compared to the preschool setting with built outdoor yards. Nature does not offer direct environmental cues for sitting, rather nature offers possibilities for open movement and flexibility. Children who regularly attend preschool may get bored with the same daily alternatives for playing in the preschool yard and PA opportunities in a yard may be less challenging; nature, however, challenges children's imagination differently and diversely [42]. Fixed playground equipment often involve closed or fixed ways of moving and can encourage more sedentary-type activities (e.g., sandboxes and swings are typical equipment in a yard). Therefore, nature may be especially important for children who tend to play more passively in playgrounds [21]. Nature seems to encourage all children, despite their age, size or other personal characteristics, to get involved in creativity and spontaneous exploration; thus all children may easily discover their own type of active play [21, 43, 44]. Consequently, developing public health strategies that increase nature visits at an early age is relevant. Additionally important is determining whether all kinds of outdoor activities play a similar role in children's movement behaviors. Measuring the length of outdoor activities in each preschool group was impossible in our study; this may be a relevant factor, however. Children may have short intense bouts of activity, lasting less than 15 minutes, at the start of outdoor free-play periods in a preschool yard following extended periods of ST. Breaking outdoor times into shorter periods of time may therefore be more beneficial. [19, 45, 46]

Our study examined the associations between multiple weekly or daily structures and children's ST during the same measurement week. However, none of the measured weekly practices were significantly associated with children's ST. Other studies have found similar results [15, 17, 47]. A comparative study between preschools in the USA and Sweden found differences in the daily routines and the supervision of children's behaviors at preschools. In the USA, rules, routines and adult leadership caused children to interrupt their ongoing activity, and many of the everyday routines were associated with children either being instructed or encouraged to stay inactive. However, Swedish preschools had shorter periods of mandatory or encouraged SB periods, with mainly one to two daily teacher-led sessions involving all children, during which they sat in a circle on the floor and were expected to stay calm [15]. In the UK, Hesketh et al. discovered the limited influence of preschool environment on children's movement behaviors, with children's individual activity preferences playing a bigger role [17] . To summarize these comparisons with the results of our study, a less structured preschool day may result in the preschool environment exerting a smaller influence on children's movement behaviors. Therefore, differences in children's ST concern other factors, for example, children's individual characteristics. Overall, these different findings between studies highlight sociocultural differences between countries, which need to be better accounted for when developing methods to measure factors associated with children's ST in preschool settings.

We did not measure the actual content of each these measured daily structures. For instance, we did not know what children actually did when they were outside or had free-play sessions. During the free-play sessions and outdoor time, children can usually choose from a range of multiple options, from sedentary alternatives to more PA-related active play. Previous studies have indicated that children's individual characteristics, for instance gender and temperament, are associated with children's ST in preschool [1, 48, 49]. Consequently, early educators may have little control over the type of activity a child partakes in during free-play or outside sessions, as children's individual characteristics may play a bigger role. Notably, children self-select their own activities daily, meaning that one day they may choose more sedentary activities, whereas another day, more active play [17]. Studies have shown that children spend less than 50% of time in PA during free-play periods, suggesting that adding structure to these periods may increase the amount of PA [12, 50, 51]. Structure could involve providing equipment for children with instructions on how to use the equipment, or teachers' prompts, encouragement or playing together with children [12, 51]. Interestingly, children with low levels of PA may benefit from this structured-type of free play, whereas the most active children often benefit more from having less structure [51]. Thus, each

child needs to learn to sit still and develop their cognitive and self-regulation skills during their preschool years, but more essential is discovering how to break children's ST and find optimally short bouts of ST during preschool hours. Therefore, studying the role of children's individual characteristics may be necessary in explaining children's ST.

Early educators play an important role in determining ST and PA; however, socially relevant is the other children in the preschool group and their influence on children's behavior. Over time, children's PA and dietary intake tend to become similar to their peers' levels in a preschool group [52]; children's PA levels are often higher in the presence of peers [53]. A recent study observed that the most active children tend to seek other physically active children, whereas children who are introverted or who may not have close friendships with their peers may feel uncomfortable or excluded and revert to low- intensity physical activities [51]. Teacher-led sessions are usually pre-planned, with guided participation of children; all the children in a group usually conduct similar activities, allowing less freedom for children's individual choice of activities [14]. However, other studies support teacher-led activities, claiming they increase children's movement and activity levels compared to free-play sessions [48, 54, 55]. Therefore, essential is determining the most effective type of social influence, adult-initiated or child-initiated, in decreasing children's ST. For instance, children with particular temperament traits may benefit more from adults' than peers' role modelling.

Our study introduced novel knowledge by studying the organizational factors associated with children's ST; this is essential information according to a recent review [56]. An additional strength of our study concerns the information collected from the preschool groups regarding time-stamped weekly practices during the week when children wore an accelerometer. We measured the associations between multiple places encouraging for PA and children's ST instead of measuring total outdoor time or combined indicators of activities. The novelty of this study concerns the information provided on whether all types of PA places similarly decrease children's ST. The random selection technique enabled our study sample to cover large and small preschools situated in both urban and countryside environments in different municipalities. Therefore, our sample widely represents activities conducted in Finnish preschools, simultaneously preventing a limited focus on certain areas (e.g., urban). However, our study had some shortcomings. We did not collect any information of preschools that refused to participate in our study. Thus, a selective group of preschools might have participated in our study. We did not receive weekly programs from all the participating groups and the drop-out rate (40%) was quite high; we cannot estimate the reasons for

this non-response. We could not measure the actual length (in minutes or hours) of the weekly practices to allow measuring whether differences existed in the lengths of activities between preschools. In addition, categorisation of the explanatory factors may influence in the results we found. Due to limited sample size, we were not able to make sensitivity analyses (e.g. testing potential interaction effect of gender and age). Although accelerometers are commonly used and can measure children's movement behaviors in free-living conditions, notably, accelerometers cannot always distinguish between sitting and standing. Additionally, differently used cut-points and data reduction methods may influence the dissimilarity in the results of different studies. The nap times were not separated from the accelerometer data, which might overestimate the time spent in SB. The cross-sectionality of this data does not allow drawing conclusions on the causality of the studied associations. We found only one statistically significant associations out of all the tested associations in our analyses. It may be that the increased number of statistical tests performed increased the potential for type 1 error. In addition, our effect sizes were small. However, these results may have practical importance when developing the effective interventions aiming to reduce children's ST. Important to notice is the existence of multiple unexplored social- and individual factors that may affect children's preschool behavior at this age, requiring further investigation with high quality and reliable measures.

CONCLUSION

This study assessed whether preschool weekly routines are associated with children's ST, and whether more frequent visits to places encouraging PA are associated with children's ST. Of the tested associations, more frequently conducted nature trips were associated with lower children's ST. Nature may challenge children to use their creativity in various activities, and also encourages all children to walk and take steps in different ways than in the more-structured type of places. Based on our study, routines and structures in the preschool setting have little influence on children's ST. Future studies could determine whether other factors, for instance children's individual characteristics, play a bigger role in explaining children's ST.

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Author Contributions: SM drafted the manuscript and conducted the analyses of this study. ER and RL helped in conducting the analyses and drafting the manuscript. CR, NS, HK and ME helped in

drafting the manuscript. SM, RL, CR, NS, ME and ER were involved in the design of the study and in seeking funding for it. ER was the principal investigator of the DAGIS study and was responsible for the study conduct. All authors revised the article critically for important intellectual content and approved the final manuscript.

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Conflicts of interest: none

Ethics approval: the University of Helsinki Review Board in the Humanities and Social and Behavioral Sciences. A parent or legal guardian of each participating child provided an informed consent.

Patient and public involvement: No patient involved

Data sharing statement: Researchers interested in the data from this study may contact principal investigator Eva Roos, eva.roos@folkhalsan.fi.

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Figure 1. The flow chart of participation in the DAGIS cross-sectional study.

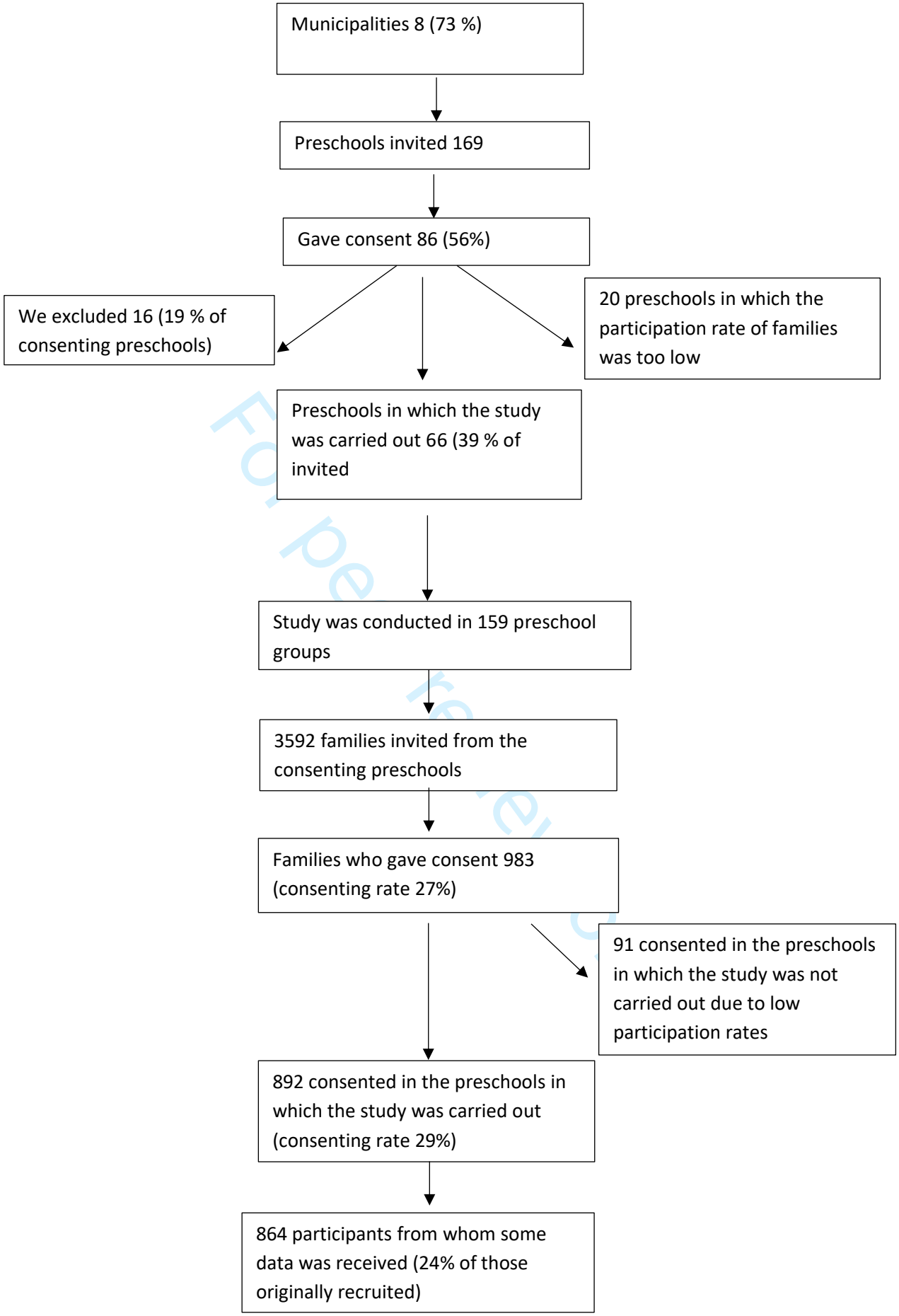

Figure 1. The flow chart of participation in the DAGIS cross-sectional study.

Supplementary Table 1. Spearman correlations between the measures used in the study (listwise N=757)

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Children's sedentary time in preschool (min/hour)										
2. Times of outdoor time	-0.060									
3. Times of teacher-led sessions	0.078	-0.335***								
4. Times of free play	-0.006	-0.258***	-0.243***							
5. Times of organized PA lessons	0.120**	-0.159***	0.097*	-0.033						
6. Times of mixed activity	0.762	-0.166***	-0.290***	-0.063	0.058					
7. Frequency of nature trips	0.042	0.041	-0.112**	0.038	-0.084	0.017				
8. Frequency of visits to play parks	0.089	0.019	0.000	-0.097*	0.054	0.045	0.133***			
9. Frequency of visits to neighborhood sport facilities	-0.010	-0.315***	0.039	-0.057	0.069	0.176***	0.092*	0.207***		
10. Frequency of visits to gym or other indoor facility	-0.015	-0.029	0.678	-0.196***	0.027	-0.034	-0.015	0.105**	0.235***	
11. Frequency of field trips to neighborhoods	0.032	-0.096*	0.237***	-0.091*	-0.011	0.108*	0.237***	0.198***	0.160***	0.040

*p<0.05, **p<0.01, ***p<0.001

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1	Preschool group practices and preschool children's sedentary time: a cross-sectional study in Finland
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2	abstract
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4	Introduction
Objectives	3	State specific objectives, including any prespecified hypotheses	5	The aim of this study is twofold: a) to study the associations between weekly routines in preschool (e.g., times of outdoors, teacher-led sessions, free play) and children's ST and b) to determine the existence of associations between more frequent visits to places encouraging PA (e.g., frequency of visits in nature or gym and field trips to neighborhoods) and children's ST.
Methods				
Study design	4	Present key elements of study design early in the paper	6	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7	a cross-sectional study was conducted between

				autumn 2015 and spring 2016….
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection participants	6-7	A total of 983 parents (27% of contacted parents) gave written permission for their child to participate in the study
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8	Indicators of sedentary behaviors Children wore an Actigraph W-GT3X accelerometer…
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6-8*	Research assistant attached accelerometer to the child's waist in the preschool.
Bias	9	Describe any efforts to address potential sources of bias	6	A major recruitment criterion was that there had to be at least one group of children aged 3-6 in the preschool. Eighty-six heads of preschools (56% participation rate) gave their written consent for participation in the study.
Study size	10	Explain how the study size was arrived at	9	Of these participating children, a total of 821 children (95% of the participants) had some accelerometer data to use in forming the variables,

	and of them, 778 had the required amount of accelerometer data for preschool hours.

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8	Early educators in preschool groups completed a program of their activities during the week that children in their group wore an accelerometer
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7	The analyses were adjusted the child's age and gender…
		(*b*) Describe any methods used to examine subgroups and interactions	7-8	Due to limited sample size, we were not able to make sensitivity analyses
		(*c*) Explain how missing data were addressed		
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	7	The non-independence of observations due to cluster sampling (children in the preschool groups) was taken into account in the analyses,
		(*e*) Describe any sensitivity analyses	7-8	Due to limited sample size, we were not able to make sensitivity analyses
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9	Of the 864 participating children, 48% were girls, the average age of participants was 4.7 years (standard deviation 0.89) and the children spent on average 34.6 hours per week in preschool (standard deviation 8.8).
		(b) Give reasons for non-participation at each stage	Figure 1 and page 15	we cannot estimate the reasons for this non-response.
		(c) Consider use of a flow diagram	Figure 1	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9	Table 1 and result section

		(b) Indicate number of participants with missing data for each variable of interest	Table 1, Table	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposu		
		Cross-sectional study—Report numbers of outcome events or summary measures	?	Results section
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	, plus supplementary Table 1 with correlations	The analyses were adjusted for municipality, the child's age and gender, and the season during which the accelerometer was used…
		(*b*) Report category boundaries when continuous variables were categorized	Table 1	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	supplementary file	
Discussion				
Key results	18	Summarise key results with reference to study objectives	10	This study aimed to
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-13	
Generalisability	21	Discuss the generalisability (external validity) of the study results	13	that it encompasses a large sample, including children from 66 different preschools in various municipalities
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13	This study was financially supported

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

ON THE BEHALF OF THE AUTHORS,