BMJ Open

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

Suvi Määttä ,[1,2] Reetta Lehto ,[1] Hanna Konttinen,[2,3] Carola Ray,[1] Nina Sajaniemi,[4] Maijaliisa Erkkola,[3] Eva Roos[1,3]

To cite: Määttä S, Lehto R, Konttinen H, *et al*. Preschool group practices and preschool children's sedentary time: a cross-sectional study in Finland. *BMJ Open* 2019;**9**:e032210. doi:10.1136/bmjopen-2019-032210

► Prepublication history and additional material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2019-032210).

Received 07 June 2019
Revised 13 November 2019
Accepted 18 November 2019

[1]Folkhälsan Research Center, Helsinki, Finland
[2]Faculty of Social Sciences, Helsinki University, Helsinki, Finland
[3]Department of Food and Environmental Sciences, University of Helsinki, Helsinki, Finland
[4]Department of Education, University of Helsinki, Helsinki, Finland

Correspondence to
Suvi Määttä;
suvi.maatta@folkhalsan.fi

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 (eg, free play and outdoor time) or be still (eg, teacher-led sessions and 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 the 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 min per preschool day, at least 2 days) the accelerometer during preschool hours. Each preschool group reported their weekly schedule during the week, and one early educator completed a 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), organised 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), neighbourhood sport facilities (no visits at all/others), visits to gym or other indoor facility (no visits at all/others) and field trips to neighbourhoods (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 to −0.248).

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

Strengths and limitations of this study

- The major strength is that we have measured the associations between multiple places encouraging for physical activity and children's sedentary time 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 programme from all the participating groups (the drop-out rate is 40%).

INTRODUCTION

Preschool-aged children, roughly 3 to 5 years, are commonly assumed as being inherently active, moving throughout the day mainly in random and intermittent ways (eg, unstructured active play). However, contrary to expectations, recent meta-analysis states that preschool-aged children spend approximately 50% of their waking hours in sedentary behaviour.[1] Sedentary behaviour (SB) is defined as any waking behaviour characterised by an energy expenditure ≤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 behaviours.[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 behaviour habits, SB habits tend to track from early childhood to later in life, thus predicting future health behaviours.[5] The preschool-age period may therefore serve as an ideal time frame for minimising ST and promoting more active movement behaviours such as active play and physical activity (PA).

It is widely encouraged to recognise better the setting-specific correlates of children's ST.[6] Alongside home, early childhood

education and care setting such as preschool play an important role in shaping children's behaviour. 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 3 to 5 with different socioeconomic backgrounds attend preschool at approximately similar rates to other Orgnization for Economic Cooperation and Development countries.[7] According to a recent review, which was based on 55 studies conducted in preschool-type settings, children's ST ranged between 12 and 55 min 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 a physical and social context where ST occurs.[10] ST in different behaviour settings has likely distinct correlates because of both the attributes of the setting and the social frame around this setting shape behaviour.[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 (eg, morning circles and group activities) may encourage ST in the preschool setting, whereas in the home setting, children may have a 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 preplanned 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 recognised both social situations (eg, children sit when teachers tell instructions in PA lessons) and structured daily activities (eg, meal times and group sessions) in the preschool that required sitting.[13] Similarly, other studies have noticed that the regular structures in the preschool setting support certain appropriate behaviour leading to school-type behaviour[14–16] although it is also suggested that preschool setting may explain little the variance in children's movement behaviours.[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. The child usually attends half (4 hours) or full (8 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 programme conducted in these slots can be divided either into activities that provide the possibility for movement (eg, free play, outdoor time and PA-related field trips such as nature trips) or non-movement type activities (eg, sitting-based circles and 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% of each preschool day in Finland and are physically active at any intensity level for <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 the 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 organising 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 (eg, times of outdoors, teacher-led sessions and free play) and children's ST and (2) to determine the existence of associations between more frequent visits to places encouraging PA (eg, frequency of visits in nature or gym and field trips to neighbourhoods) and children's ST.

METHODS

Study context

Municipalities are responsible for organising 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 7, the children attending preschool are usually aged 1 to 6 years. Preschool children are enrolled in formal childcare for an average of ≥30 hours per week.[24] Preschool care in Finland is subsidised; the maximum monthly fee is €290 (as of 2018). Family income and family size are accounted for in determining the fee.[25]

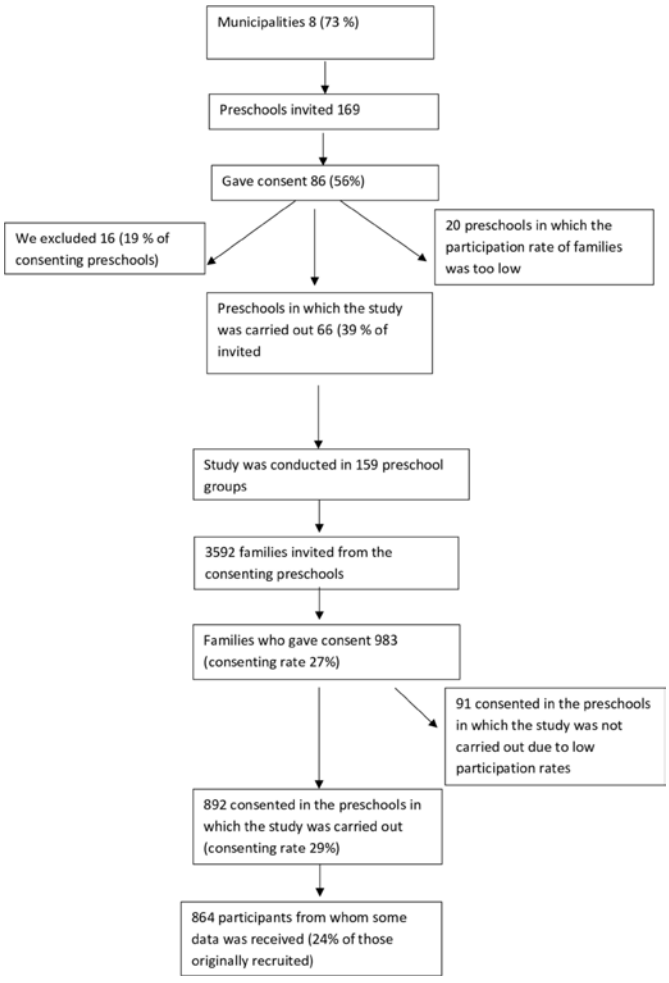

Figure 1 The flowchart of participation in the DAGIS cross-sectional study.

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 3 to 6. Purely preprimary education groups only for 6 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 16 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 <30% of the children in one preschool group were willing to participate in the study. Of the consenting preschools, 20 failed to reach the required 30% participation rate. Thus, the study was conducted in 66 preschools (39% of those invited). These preschools had a total of 159 preschool groups (ranging from one to five groups in each preschool) with children aged 3 to 6.

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 <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 informed consent. The University of Helsinki Ethical Review Board in the Humanities and Social and Behavioral Sciences approved the study procedures (6/2015, approved on 25 February 2015). Figure 1 summarises 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, USA). 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 the following 7 days. Following data collection, the epoch length was set at 15 s. Periods of ≥10 min 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 s),[33] a good estimate of free-living ST.[34] Parent-provided information about the daily preschool hours was 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 min per day for at least 2 days. Because preschool hours varied between children, the final outcome measure was formed so total ST minutes in preschool were 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 programmes

Early educators in preschool groups completed a programme of their activities during the week that children in their group wore an accelerometer. This programme 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 categorised 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 organising the play), 4=organised PA lessons (organised PA lesson either outside or inside, although clearly being a teacher-led, organised 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 3 days with full details of activities. This score was then divided by the number of the days (from 3 to 5) to form the average daily amount of each activity. The measures related to free play, organised 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. 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 behaviours 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

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

Preschool group practices		Descriptive	Descriptive	No preschool groups (N)
Weekly structures				
Times of outdoors		Mean 2.45 times per day	SD 0.69	96
Times of teacher led sessions		Mean 0.76 times per day	SD 0.67	96
Times of free play	Low (not at all)	45%	n=43 preschool groups	96
	Middle (between 0.1 and 0.8 times per day)	31%	n=30 preschool groups	
	High (between 0.81 and 4 times per day)	24%	n=23 preschool groups	
Times of organised 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	SD 0.62	138
Frequency of visits to play parks		Mean 0.41 times per week	SD 0.72	139
Frequency of visits to neighbourhood 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 neighbourhoods		Mean 0.52 times per week	SD 0.56	134

PA, physical activity.

was related to PA possibilities. First, 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, neighbourhood 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 neighbourhoods 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 neighbourhood 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.

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 to 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 programme V.24 (SPSS Inc.,Chicago, Illinois, USA), whereas the multilevel linear regression models were run using the Mplus programme V.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 centred[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 (SD 0.89) and the children spent on average 34.6 hours per week in preschool (SD 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 min/h (SD 5.10 min).

Of the 159 possible groups (82% response rate), a total of 131 preschool groups completed the weekly programme. Of this total number, 96 groups had complete information on their activities from at least 3 days (73% of the possible programme). 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 (SD 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 explanatory factors and children's ST can be found in the online supplementary table 1.

Table 2 presents the results of the multilevel linear regression analyses to study the associations between weekly routines in preschool or more frequent visits to places encouraging for PA, and children's ST. Out of 10 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.

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] A potential explanation for children's lower ST levels in

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 *	Low	−0.655	−2.626	1.316	0.515	470
	Middle	−1.206	−3.312	0.901	0.262	
	High (reference)					
Times of organised PA lessons †		0.661	−0.730	2.052	0.352	470
Times of mixed activity‡		−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 neighbourhood sport facilities §		−0.520	−1.558	0.519	0.327	654
Frequency of visits to gym or other indoor facility ¶		0.184	−0.913	1.281	0.742	671
Frequency of field trips to neighbourhoods		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.
*Treated as categorised.
†Treated as dichotomous; no lessons at all (0) and others (1).
‡Treated as dichotomous; no mixed activities (0) and others (1).
§Treated as dichotomous; no visits at all (0) and others (1).
¶Treated as dichotomous; no visits at all (0) and others (1).
PA, physical activity.

nature is that nature challenges all children in different ways, compared with 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 (eg, 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 behaviours. 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 <15 min, 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 behaviours 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 and van Sluijs discovered the limited influence of preschool environment on children's movement behaviours, with children's individual activity preferences playing a bigger role.[17] To summarise 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 behaviours. 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 of these measured daily structure. 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 <50% of the time in PA during free-play periods, suggesting that adding structure to these periods may increase the amount of PA.[12 50 51] The 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 for 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 behaviour. 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 preplanned, 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 with 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 organisational 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 (eg, 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 programme 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 the results we found. Due to the limited sample size, we were not able to make sensitivity analyses (eg, testing potential interaction effect of gender and age). Although accelerometers are commonly used and can measure children's movement behaviours 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 these data does not allow drawing conclusions on the causality of the studied associations. We found only one statistically significant association 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 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 behaviour at this age, requiring further investigation with high quality and reliable measures.

CONCLUSIONS

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.

Acknowledgements The authors thank the preschools and their personnel, and the parents for their participation in the DAGIS study, and the staff for the data collection.

Contributors 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: involved in the design of the study and in seeking funding for it. ER: 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.

Funding The first author of this manuscript was financially supported by the Juho Vainio Foundation. This study was financially supported by the Folkhälsan Research Centre, The Ministry of Education and Culture in Finland, The Academy of Finland (Grant: 285439), The Juho Vainio Foundation, The Yrjö Jahnsson Foundation, the Signe and Ane Gyllenberg Foundation, The Finnish Cultural Foundation/South Ostrobothnia Regional Fund, the Päivikki and Sakari Sohlberg foundation, and the Medicinska Föreningen Liv och Hälsa.

Competing interests None declared.

Patient consent for publication Not required.

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

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

ORCID iDs
Suvi Määttä http://orcid.org/0000-0001-9771-5720
Reetta Lehto http://orcid.org/0000-0002-2289-2746

REFERENCES

1 Pereira JR, Cliff DP, Sousa-Sá E, *et al*. Prevalence of objectively measured sedentary behavior in early years: systematic review and meta-analysis. *Scand J Med Sci Sports* 2019;29:308–28.
2 Tremblay MS, Aubert S, Barnes JD, *et al*. Sedentary behavior research network (SBRN) – terminology consensus project process and outcome. *Int J Behav Nutr Phys Act* 2017;14.
3 Kuzik N, Carson V. The association between physical activity, sedentary behavior, sleep, and body mass index z-scores in different settings among toddlers and preschoolers. *BMC Pediatr* 2016;16.
4 Biddle SJH, Pearson N, Salmon J. Sedentary behaviors and adiposity in young people: causality and conceptual model. *Exerc Sport Sci Rev* 2018;46:18–25.
5 Jones RA, Hinkley T, Okely AD, *et al*. Tracking physical activity and sedentary behavior in childhood. *Am J Prev Med* 2013;44:651–8.
6 Sallis JF, Owen N, Fisher EB. Ecological models of health behavior. In: Glanz K, Rimer BK, Ke V, eds. *Health behavior and health education: theory, research, and practice*. San Francisco CA: Jossey-Bass, 2008: 465–82.
7 OECD. *orgnization for economic cooperation and development. family database, PF3.2*. Enrolment in Childcare and Pre-Schools, 2016.
8 O'Brien KT, Vanderloo LM, Bruijns BA, *et al*. Physical activity and sedentary time among preschoolers in centre-based childcare: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity* 2018;15:117–16.
9 Hnatiuk JA, Salmon J, Hinkley T, *et al*. A Review of Preschool Children's Physical Activity and Sedentary Time Using Objective Measures. *Am J Prev Med* 2014;47:487–97.
10 Owen N, Sugiyama T, Eakin EE, *et al*. Adults' sedentary behavior determinants and interventions. *Am J Prev Med* 2011;41:189–96.
11 Spence JC, Rhodes RE, Carson V. Challenging the Dual-Hinge approach to intervening on sedentary behavior. *Am J Prev Med* 2017;52:403–6.
12 Ward S, Bélanger M, Donovan D, *et al*. Systematic review of the relationship between childcare educators' practices and preschoolers' physical activity and eating behaviours. *Obes Rev* 2015;16:1055–70.
13 Määttä S, Ray C, Roos G, *et al*. Applying a Socioecological Model to Understand Preschool Children's Sedentary Behaviors from the Viewpoints of Parents and Preschool Personnel. *Early Childhood Education Journal* 2016;44:491–502.
14 Kounin JS, Sherman LW. School environments as behavior settings. *Theory Pract* 1979;18:145–51.
15 Raustorp A, Pagels P, Boldemann C, *et al*. Accelerometer measured level of physical activity indoors and outdoors during preschool time in Sweden and the United States. *J Phys Act Health* 2012;9:801–8.
16 De Decker E, De Craemer M, De Bourdeaudhuij I, *et al*. Influencing factors of sedentary behavior in European preschool settings: an exploration through focus groups with teachers. *J School Health* 2013;83:654–61.
17 Hesketh KR, van Sluijs EMF. Features of the UK childcare environment and associations with Preschooler's in-care physical activity. *Prev Med Rep* 2016;3:53–7.
18 Tammelin TH, Aira A, Hakamäki M, *et al*. Results From Finland's 2016 Report Card on Physical Activity for Children and Youth. *J Phys Act Health* 2016;13:S157–64.
19 Truelove S, Bruijns BA, Vanderloo LM, *et al*. Physical activity and sedentary time during childcare outdoor play sessions: a systematic review and meta-analysis. *Prev Med* 2018;108:74–85.
20 Bingham DD, Costa S, Hinkley T, *et al*. Physical activity during the early years: a systematic review of correlates and determinants. *Am J Prev Med* 2016;51:384–402.
21 Bjørgen K. Physical activity in light of affordances in outdoor environments: qualitative observation studies of 3-5 years olds in kindergarten. *Springerplus* 2016;5:950. eCollection 2016.
22 Dowda M, Pate RR, Trost SG, *et al*. Influences of preschool policies and practices on children's physical activity. *J Community Health* 2004;29:183–96.
23 De Decker E, De Craemer M, De Bourdeaudhuij I, *et al*. Influencing factors of sedentary behavior in European preschool settings: an exploration through focus groups with teachers. *J Sch Health* 2013;83:654–61.
24 National Institute for Health and Welfare. *Lasten päivähoito [Children's early childhood education and care 2015], Statistical report 21/2019, 29.12.2016*, 2016.
25 Finnish National Agency for Education. *National core curriculum for early childhood education and care*, 2016.
26 Lehto E, Ray C, Vepsäläinen H, *et al*. Increased Health and Wellbeing in Preschools (DAGIS) Study—Differences in Children's Energy Balance-Related Behaviors (EBRBs) and in Long-Term Stress by Parental Educational Level. *Int J Environ Res Public Health* 2018;15:2313.
27 Määttä S, Lehto R, Nislin M, *et al*. Increased health and well-being in preschools (DAGIS): rationale and design for a randomized controlled trial. *BMC Public Health* 2015;15:402.
28 National Institute of Health and Welfare. *Welfare COMPASS for monitoring regional welfare*, 2017.
29 Janssen X, Cliff DP, Reilly JJ, *et al*. Predictive validity and classification accuracy of ActiGraph energy expenditure equations and cut-points in young children. *PLoS One* 2013;8:e79124.
30 Pate RR, Almeida MJ, McIver KL, *et al*. Validation and calibration of an Accelerometer in preschool Children*. *Obesity* 2006;14:2000–6.
31 Adolph AL, Puyau MR, Vohra FA, *et al*. Validation of uniaxial and Triaxial Accelerometers for the assessment of physical activity in preschool children. *J Phys Act Health* 2012;9:944–53.
32 Puyau MR, Adolph AL, Vohra FA, *et al*. Validation and calibration of physical activity monitors in children. *Obes Res* 2002;10:150–7.
33 Evenson KR, Catellier DJ, Gill K, *et al*. Calibration of two objective measures of physical activity for children. *J Sports Sci* 2008;26:1557–65.
34 Ridgers ND, Salmon J, Ridley K, *et al*. Agreement between activPAL and ActiGraph for assessing children's sedentary time. *Int J Behav Nutr Phys Act* 2012;9.
35 Androutsos O, Apostolidou E, Iotova V, *et al*. Process evaluation design and tools used in a kindergarten-based, family-involved intervention to prevent obesity in early childhood. The ToyBox-study. *Obes Rev* 2014;15:74–80.
36 Ward Det *al*. An instrument to assess the obesogenic environment of child care centers. *Am J Health Behav* 2008;32:380–6.

37 Geiser C. *Data analysis with mPLUS*. New York, NY: The Guilford Press, 2012.
38 Enders CK, Tofighi D. Centering predictor variables in cross-sectional multilevel models: a new look at an old issue. *Psychol Methods* 2007;12:121–38.
39 Brussoni M, Gibbons R, Gray C, *et al*. What is the relationship between risky outdoor play and health in children? A systematic review. *Int J Environ Res Public Health* 2015;12:6423–54.
40 Gray C, Gibbons R, Larouche R, *et al*. What is the relationship between outdoor time and physical activity, sedentary behaviour, and physical fitness in children? A systematic review. *Int J Environ Res Public Health* 2015;12:6455–74.
41 Herrington S, Brussoni M. Beyond Physical Activity: The Importance of Play and Nature-Based Play Spaces for Children's Health and Development. *Curr Obes Rep* 2015;4:477–83.
42 Gubbels J, Van Kann D, Cardon G, *et al*. Activating Childcare Environments for All Children: the Importance of Children's Individual Needs. *Int J Environ Res Public Health* 2018;15:1400.
43 Fjørtoft I. Landscape as playscape: the effects of natural environments on children's play and motor development. *Child Youth Environment* 2004;14:21–44.
44 Sandseter EBH. Affordances for risky play in preschool: the importance of features in the play environment. *Early Childhood Education Journal* 2009;36:439–46.
45 Pate RR, Dowda M, Brown WH, *et al*. Physical activity in preschool children with the transition to outdoors. *J Phys Act Health* 2013;10:170–5.
46 Razak LA, Yoong SL, Wiggers J, *et al*. Impact of scheduling multiple outdoor free-play periods in childcare on child moderate-to-vigorous physical activity: a cluster randomised trial. *Int J Behav Nutr Phys Act* 2018;15:34.
47 Hesketh KR, Benjamin-Neelon SE, van Sluijs EMF. How does the UK childcare energy-balance environment influence anthropometry of children aged 3–4 years? A cross-sectional exploration. *BMJ Open* 2018;8:e021520.
48 Gubbels JS, Kremers SPJ, van Kann DHH, *et al*. Interaction between physical environment, social environment, and child characteristics in determining physical activity at child care. *Health Psychol* 2011;30:84–90.
49 Schmutz EA, Leeger-Aschmann CS, Radtke T, *et al*. Correlates of preschool children's objectively measured physical activity and sedentary behavior: a cross-sectional analysis of the SPLASHY study. *Int J Behav Nutr Phys Act* 2017;14.
50 Bower JK, Hales DP, Tate DF, *et al*. The Childcare Environment and Children's Physical Activity. *Am J Prev Med* 2008;34:23–9.
51 Frank ML, Flynn A, Farnell GS, *et al*. The differences in physical activity levels in preschool children during free play recess and structured play recess. *J Exerc Sci Fit* 2018;16:37–42.
52 Ward SA, Bélanger MF, Donovan D, *et al*. Relationship between eating behaviors and physical activity of preschoolers and their Peers: a systematic review. *Int J Behav Nutr Phys Act* 2016;13.
53 Ward S, Bélanger M, Donovan D, *et al*. "Monkey see, monkey do": Peers' behaviors predict preschoolers' physical activity and dietary intake in childcare centers. *Prev Med* 2017;97:33–9.
54 Fossdal TS, Kippe K, Handegård BH, *et al*. "Oh oobe doo, I wanna be like you" associations between physical activity of preschool staff and preschool children. *PLoS One* 2018;13:e0208001.
55 Vanderloo L, Tucker P, Johnson A, *et al*. The Influence of Centre-Based Childcare on Preschoolers' Physical Activity Levels: A Cross-Sectional Study. *Int J Environ Res Public Health* 2014;11:1794–802.
56 Tonge KL, Jones RA, Okely AD. Correlates of children's objectively measured physical activity and sedentary behavior in early childhood education and care services: a systematic review. *Prev Med* 2016;89:129–39.