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Preschool children's context-specific sedentary behaviors and parental socioeconomic status: a cross-sectional study

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Abstract

Objectives: This study examined the associations of parental socioeconomic status (SES) a) with preschool children's objectively measured sedentary time (ST) over the course of a week, and b) with preschool children's parent-reported screen and reading time at home as indicators of children's sedentary behaviors (SB).

Design: As part of the larger DAGIS project a cross-sectional study was conducted in years 2015 and 2016.

Setting: Children and parents were recruited through 66 preschools located in the Western and Southern Finland

Participants: 864 children, aged 3-6 years, with their parents.

Outcome measures: Children's accelerometer data were transformed into average ST minutes per hour in different contexts (preschool, home during preschool days, weekend and total). Parent-reported children's screen and reading times were expressed as average daily minutes. The SES indicators (maternal and paternal education and relative household income) were grouped into three categories. Linear regression analysis was used, with municipality, season, and children's gender and age as covariates. Confidence intervals were adjusted for clustering at the preschool-group level.

Results: Children with low maternal (β=17.21, 95% CI: 8.71, 25.71) and paternal (β=10.54, 95% CI: .77, 20.30) education had more screen time at home than their more advantaged counterparts. Children with low as opposed to high maternal education (β=-2.66, 95% CI: -2.01, -.29) had less reading time at home. Children whose fathers were on the middle (β= -1.15, 95% CI: -2.01, -.29) educational level had less weekend ST than those with high paternal education. Otherwise, parental SES tended not to relate to objectively measured ST.

Conclusions: The results of this study highlight the fact that the associations between parental SES and preschoolers' SB are dependent on the indicators of SES and SBs, and vary between different contexts. Interventions aiming to diminish SES differences in children's SB should focus on home hours.

Keywords: sedentary lifestyle, preschool, children,socioeconomic factors

Strengths and limitations of this study:

- The major strength of this study is that sedentary behaviors were measured using parent-reported diary and accelerometer in a relative large sample of preschool children.
- The another strength of this study is that the associations between parental socioeconomic status and children's sedentary behaviors were studied in separate contexts (e.g. preschool time, weekend).
- The limitation of this study is that the hip-worn accelerometer might not effectively separate standing from sitting and reclining positions.
- The another limitation of this study is that the parent-reported diary may lead to bias in that parents might be unable to constantly monitor their children's behaviors

INTRODUCTION

Children as young as preschool age (defined here as aged 3 through 6) spend most of their waking hours in sedentary [1],defined as set of activities requiring low levels of energy and are mainly conducted in sitting or reclining positions [2]. The overall sedentary time (ST) can be broken up into separate sedentary behaviors (SB) – of which some are more harmful to health than others. The detrimental health effects of extensive screen-based SBs, especially TV viewing, on childhood obesity, other cardiometabolic risk markers, motor-skill development, psychosocial wellbeing and cognitive development are recognized in several studies [3-6]. On the other hand, a recent review points out the beneficial effects of reading (or being read to) for early-childhood cognitive development [3]. There are limited indications of associations between overall ST and health indicators among children, but clearer evidence has been found among adults [7-9]. Given the tendency for SBs to track from early childhood to later in life [10], it would be relevant to enhance understanding of their determinants in early childhood.

One important factor to be studied further is parental socioeconomic status (SES). A recent review concludes that a socioeconomic gradient for many predictors of obesity is established in early childhood, and health inequalities in early childhood predict poorer health later in life [11]. Most previous studies focus on the associations between SES and preschoolers' TV viewing, and there is concurrent evidence that preschoolers with a low SES background tend to spend more time watching TV than their counterparts with a high SES [11-13]. However,

there is very little evidence with inconsistent findings of the possible SES differences in preschoolers' objectively measured ST or in other specific SBs, such as reading and other screen-related SBs [11-14]. Other SBs are known to be major contributors to preschoolers' overall ST [15], and may have different associations with indicators of SES. Similarly, different indicators of SES (e.g. education and income) may have different associations with preschoolers' SBs.

Existing studies on preschool children also tend to concentrate on weekly average SBs without considering the possible differences over the course of the week (e.g. weekdays and at weekends) or in different settings (e.g. preschool or home). For example, there may be no SES differences in children's SBs during preschool time given that early educators predetermine most behaviors and allow little flexibility. During out-of-preschool hours (later referred as home hours), parents have more an important role for planning and deciding the activities for their children. Given that SES modifies parental attitudes, experiences, and exposures to different behaviors [16-18], the behavioral variation among children may be wider at home. The results of studies conducted among school-aged children suggest that overall ST is higher after school hours and during weekends [19, 20], hence it would be relevant to find out if there are also SES differences in ST. A previous study found that preschoolers' with higher maternal education had more ST in the evenings [21]. However, specific SBs were not observed in this study, which could explicate the SES differences in overall ST. This study examines the associations of parental SES a) with preschool children's objectively measured ST over the course of a week, and b) with preschool children's parent-reported screen and reading time at home as indicators of their SBs.

METHODS

Study design

The DAGIS (Increased Health and Wellbeing in Preschools) study is a long-term project with multiple data-collection phases. The overarching goal is to diminish socioeconomic differences in preschoolers' energy-balance-related behaviors (EBRBs)[22]. As part of this project a cross-sectional study was conducted between autumn 2015 and spring 2016, the aim being to investigate socioeconomic differences in children's EBRBs. It was a multiple-method study covering children, parents, and preschools. An ethical permit was obtained from the University of Helsinki Review Board in the Humanities and Social and Behavioral Sciences.

Study population

The cross-sectional study was conducted in eight municipalities situated in Southern and Western Finland. Municipalities in Finland are responsible for organizing preschool services based on national guidelines. Each child has a subjective right to a preschool place, and 74 percent of children aged 3-5 are in preschool. About 76 percent of all children who are in preschools attend those organized by the municipality. [23] Only municipality-based preschools were randomly selected for the study. 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. Once the willingness of the preschools was ascertained information letters and consent forms were distributed to parents via the respective schools. A major parental recruitment criterion was to have at least one child aged 3-6 attending preschool regularly. Parents of 983 children (27% consent rate) gave their written consent for the study. Given the recruitment criterion of including only preschools with more than a 30-percent consent rate in at least one of the groups, the survey was conducted in 66 preschools, among a total of 892 children whose parents had consented to their participation. However, no research data were available on 28 children, hence the final total was 864 children (24% of those invited).

MEASURES

Indicators of sedentary behaviors

Children wore an Actigraph W-GT3X accelerometer (Actigraph, Pensacola, Florida) on the hip 24 hours a day for seven days. Actigraph has been validated and used extensively as an objective measure of physical activity (PA) and ST [24-26]. Research assistant attached accelerometer to the child's waist in the preschool. The parents received written instructions about its use. During the seven days the children were wearing the accelerometers the parents filled in a diary in which they reported their child's sleeping hours and preschool hours, non-wearing times of the accelerometer, and possible sickness days.

The epoch length was set at 15 seconds. Periods of 10 minutes or more at zero accelerometer counts were considered to be non-wearing times, and were excluded. The Evenson ST cut-point ($\leq$ 100 counts per minute) was applied [27], having been shown to be a good estimate of free-living ST [28, 29]. Hours of night sleeping and reported sickness days were excluded from the analyses. Four variables with different time criteria were formed to indicate different times of the week: a) total time (at least 600 minutes per day, for at least four days with one weekend-day); b) preschool ST (at least 240 minutes per day, for at least two days); c) home ST during preschool days (the same days as used in the preschool variable); d) weekend ST

(at least 600 minutes per day). All these variables were adjusted for the wearing hours so as to indicate the children's ST minutes in an average hour in different contexts. The presented time criteria were based on previous studies that have estimated the wearing hours and days that best illustrate preschoolers' habitual ST and PA during a whole measurement week, or in separate contexts [30-32].

The above-mentioned diary included a daily report on the children's SBs that was based on previously validated method [33]. Of the original method, only the SB section was retained. We did also modifications for the original version, asking separately about TV watching and DVD/video watching, and we added the use of tablet computers and smartphones as an option. The parents were asked to state in the diary whether their child carried out any of the listed activities while sitting down or being still. They reported daily on whether the child engaged in a certain activity, how many times and for how many hours and minutes in total. They were also asked to consider only the time periods outside preschool hours. We used the following activities from the diary in the present study: reading or looking at a book (later called reading), TV watching, DVD/video watching, computer use, tablet computer and smartphone use. The reported hours and minutes devoted to these activities were transformed into minutes. The use of TV, computers, tablet computers, smartphones and DVD/Videos were combined into one variable, screen time. The weighted daily averages (5/7 on weekdays and 2/7 at weekends) of screen time and reading were calculated. No data on specific preschool-based SBs were collected.

Indicators of socioeconomic status

The educational level of both parents was reported in the consent form: they were asked to rank their highest educational attainment on a seven-item list. The response options were re-organized into three groups: a low education was defined as comprehensive schooling (usually from ages 7 to 16) to secondary education (usually ages 16 to 19); a medium level refers to a Bachelor's degree; and a high education as at least a Master's Degree.

Household income was elicited in the parental questionnaire. The parents were asked to report the extent of the entire household net income (after tax) on average per month, taking into account any regular income after tax such as earnings and capital gains, pensions, child benefits and other social benefits. The response options ranged from less than 500 (1), to over 10,000 (10) Euros per month. The total household net income was divided by the number of family members using a standard equivalence scale that gave a weight to all members of the household [34]. This relative household-income variable was categorized into tertiles. Low-

income families had a monthly-equalized income of less than 1,894 Euros, and high-income families an income of 2,501 Euros or more.

Covariates

The analyses were adjusted for municipality, the child's age and gender, and the season during which the accelerometer was used. Parents reported the child's age and gender. Age was treated as continuous variable in the analyses. The season variable was divided into three categories: 1=September-October, 2= November-December, and 3=January-April. Both the season and the municipality variables were treated as dummy variables.

Statistical analyses

The SPSS version 23 (SPSS Inc., Chicago, IL, USA) was used to derive the descriptive statistics. Screen time (N=4) and home ST (N=1) had outliers beyond three standard deviations of the mean, and were thus removed from the analyses.

Linear regression analyses were conducted to examine the associations between the SES indicators and each SB variable. For this we used Mplus Version 7.4. (Muthen & Muthen, Los Angeles, CA, USA) with Maximum Likelihood Estimation and Robust Standard Errors (MLR). The non-independence of observations due to cluster sampling (children in the preschool groups) was taken into account in the analyses, and the highest SES group was treated as a reference category.

RESULTS

Of the 864 participating children, 17 (2%) did not want to wear the accelerometer and 20 (2%) did not return the diary. In addition, two accelerometers were not installed properly and two were not returned. We therefore had data from 821 children (95% of the participants) to be used in forming the variables. In accordance with the criteria presented above, between 772 and 789 children had produced the required amount of accelerometer data for the analyses. Those who did not produce valid accelerometer data for total time and weekend ST were more likely to have a mother with a lower level of education than those who produced valid accelerometer data (data not shown). A total of 771 children filled in the diary properly. There were no differences in SES indicators between those who produced valid or invalid diary data. Parent-reported daily screen time correlated positively with objectively measured home ST (r=0.95, P=0.010) and with weekend ST (r=0.92, P=0.013), but negatively with preschool ST (r=-0.14, P=0.000). Reading did not correlate with any other outcomes. Maternal education correlated with paternal education (r=0.487, P=0.000) and relative

household income (r=0.305, P=0.000), and paternal education correlated with relative household income (r=0.320, P=0.000). Sample characteristics of the participants are described in Table 1.

Table 1 Sample Characteristics in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland (N=864)

Measure		Value [1]	N
Children's age		4.73 (.89)	864
Children's gender			
	Girls	48%	413
	Boys	52%	450
Season during which the accelerometer was worn			
	September-October	44%	354
	November-December	36%	290
	January-April	20%	164
Maternal education			
	Low (1)	30%	265
	Medium (2)	41%	358
	High (3)	29%	256
Paternal education			
	Low (1)	45%	365
	Medium (2)	33%	267
	High (3)	22%	181
Household income			
	Low (1)	32%	224
	Medium (2)	34%	232
	High (3)	34%	235
Children's sedentary time measured by the accelerometer (min/hour)			
	Total time	28.11 (4.01)	772
	Preschool	26.47 (5.11)	778

	Home time in preschool days	29.74 (4.96)	777
	Weekend	28.47 (4.76)	779
Children's sedentary time measured in the diary (min/day)			
	Screen time	111.02 (48.50)	767
	TV use	56.14 (28.20)	771
	Computer use	9.06 (20.32)	771
	Tablet/smart phone use	21.82 (26.18)	771
	DVD/video use	25.66 (30.50)	771
	Reading	19.19 (11.35)	765

[1] Values are mean (Standard Deviation) unless otherwise stated. N=864

Table 2 presents the results on the associations of maternal education, paternal education, and relative household income with objectively measured preschool children's ST in different contexts. According to the findings, children whose fathers had a medium as opposed to a high level of education had, on average, 1.2 minutes less weekend ST per hour.

Table 2. The associations between parental socioeconomic status and preschool children's objectively measured sedentary time (minutes/hour) over the course of the week measured by means of linear regression models, adjusted for municipality, season, and the children's gender and age in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland

Socioeconomic status Indicator	Sedentary time in preschool			Home sedentary time in preschool days			Sedentary time in weekends			Total sedentary time		
	β	Lower 95% CI	Higher 95% CI	β	Lower 95 % CI	Higher 95% CI	β	Lower 95% CI	Higher 95% CI	β	Lower 95% CI	Higher 95% CI
Maternal education (N between 738 – 744)												
Low	.46	-.45	1.36	.47	-.53	1.47	-.09	-.71	.90	.33	-.35	1.00
Medium	-.53	-1.37	.31	.44	-.28	1.17	-.17	-.94	.59	-.22	-.83	.40
High (reference)												
Paternal education (N between 682 – 691)												
Low	-.17	-1.14	.79	.05	-.86	.96	-.49	-1.25	.27	-.02	-.68	.63
Medium	-.28	-1.28	.72	.10	-.78	.99	-1.15	-2.01	-.29	-.46	-1.10	.18
High (reference)												
Household income (N between 639 – 646)												
Low	.47	-.34	1.28	-.85	-1.76	.06	-.52	-1.27	.24	-.11	-.74	.51
Medium	-.34	-1.16	.49	-.22	-.99	.54	-.05	-.83	.73	-.13	-.69	.44
High (reference)												

Table 3 presents the results on the associations of maternal education, paternal education, and family income with their children's daily screen time and reading time at home. Compared to children whose mothers had a high level of education, those with a low or a medium level of maternal education had, respectively and on average, 17.21 and 11.17 minutes more screen time daily. Children whose fathers had a low level of education had 10.54 minutes more screen time than their counterparts with high paternal education. Children whose mothers had a low level of education had, on average, 2.66 minutes less reading time daily than their counterparts with high maternal education.

Table 3. The associations between parental socioeconomic status and preschool children's daily average screen and reading time at home measured by means of linear regression analysis, and adjusted for municipality, research time, and the children's gender and age in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland

Socioeconomic status	Daily screen time at home (min/day)			Daily reading time at home (min/day)		
Indicator	β	Lower 95% CI	Higher 95% CI	β	Lower 95% CI	Higher 95% CI
Maternal education (N between 726 – 728)						
Low	17.21	8.71	25.71	-2.66	-4.95	-.38
Medium	11.17	3.69	18.64	-1.82	-3.79	.15
High (reference)						
Paternal education (N between 674 – 676)						
Low	10.54	0.77	20.30	-2.31	-4.85	.23
Medium	-1.17	-11.07	8.74	-1.66	-4.32	.99
High (reference)						
Household income (N=628)						
Low	9.82	-.13	19.78	-1.34	-3.60	.92
Medium	6.60	-2.41	15.60	.14	-2.07	2.34
High (reference)						

DISCUSSION

In sum, the main findings of this study show that children with low parental education had more screen time at home than their counterparts with highly educated parents, whereas those whose mothers had a higher as opposed to a lower level of education had more reading time. Otherwise, parental SES was mainly unrelated to the children's objectively measured ST over the course of the week.

The findings also revealed that preschoolers with lower parental education had between 10 (paternal education) and 17 (maternal education) minutes more daily screen time at home than their counterparts with higher parental education. Previous studies have also reported a similar pattern of SES differences [11], but this study brings additional knowledge that the overall screen time not only TV viewing is higher among preschoolers with low parental education. Different types of screens have become part of everyday life in families with preschoolers, and controlling screen use may be difficult for parents. Higher as opposed to lower parental education is usually related to enhanced awareness, capabilities and skills in terms of adopting a healthy lifestyle [17]. Screen-time reduction may require additional resources (e.g. financial, time) that parents are not necessarily able to provide, which in turn could add to parental stress [35, 36]. Stress in combination with a lack of resources might make it challenging for parents with a low educational level to limit screen time among their children.

Parents seem to value optimal cognitive development during early childhood [37]. Previous studies have illustrated that parents of preschool-aged children consider screen-time activities to be good educational tools, whereas the detrimental effects of extensive screen time on cognitive development is not mentioned [38-41]. These studies have not taken possible SES differences into consideration. Parents with a higher level of education might realize the harmful health effects of increased screen time and place more value on their children's educational achievements, and therefore encourage them to spend more time with books instead of watching a screen. It may be that parents with a low educational background do not realize the detrimental effects of screen time on cognitive development, and place more value on the educational aspects. Still, it should be acknowledged that some aspects of screen time could be educational. Applications in touch-screen devices such as tablet computers and smart phones are being used to an increasing extent as learning tools in preschools, for example.

However, there is little current research about the real educational benefits of using these tools [42]. The results of some studies suggest that the use of touch-screen devices inhibits social interaction and children's ability to self-regulate their behavior, although benefits related to early literacy skills, the stimulation of concentration and the fostering of independent learning are also acknowledged [42]. Nevertheless, screen time is usually sedentary in nature, and it is therefore important to limit its use.

The finding that reading and screen time had opposite relationships with parental SES attests to the necessity of measuring different types of SBs to fully understand the SES differences. SES differences in reading time in early childhood are seldom addressed in SB studies, for example, although its beneficial influences on cognitive development and school readiness are recognized [3, 43]. These contradictory SES associations with different types of SBs could also partly explain the few associations between overall objectively measured ST and indicators of SES found in this study. It would therefore be relevant to consider whether it might be more worthwhile focusing on the type of SB than overall ST in research on SES differences in children's SB. Similarly, the wide variation of screens currently available ensures variation in the way they are used. Tablet computers and mobile devices are used not only as behavioral-control tools to calm down or distract children in restaurants and cars, but also for educational purposes [35, 42, 44]. It may be worth considering the context in which the devices are used in future studies, as well as potential SES differences in the way they are used.

We did not find any SES differences in ST during preschool hours: to our knowledge, no other studies have addressed this issue. However, our finding is inconsistent with a previous study on school-aged children reporting that offspring with parents educated to university level or higher had less ST in schools than children with less highly educated parents [45]. The school setting with its compulsory lessons is different than the preschool setting, however. The Finnish preschool model is based on learning by playing, and compulsory pre-primary education in preparation for official schooling starts at the age of six [46]. We excluded pre-primary education classes during the recruitment phase of the DAGIS study. However, we did not measure children's specific SBs during preschool hours in more detail: we thought it would be too time-consuming to list specific SBs in diaries for each child in the preschool group. According to our preparatory work before we conducted this cross-sectional survey, the availability of screens in Finnish preschools is limited [47]. More research is therefore needed to shed light on the role of preschools in balancing SES differences in

children's SB. Future studies could compare the associations between SES and SB among children who are attending preschool and those who are mainly cared for at home, for example.

There are some limitations that should be taken into account in interpreting the results of our study. The DAGIS study is cross-sectional, and therefore the causality between parental SES and children's SB cannot be fully established. There are several accelerometer cut-points for ST among preschool children, and there is no consensus as to which are the most suitable. However, the results of a recent comparative study support the choice of Evenson cut-points for measuring ST [48]. Moreover, the hip-worn accelerometer might not give the most accurate measurements because it does not effectively separate standing from sitting and reclining positions [28]. The information on children's screen time and reading was based on parental reports, and as with any other reported information, proxy reports may lead to bias in that parents might be unable to constantly monitor their children's behaviors [49, 50]. Nevertheless, the diary is generally considered to be more reliable than a few items in a questionnaire [51]. A major strength of this study is that it encompasses a large sample, including children from 66 different preschools in various municipalities. Another strength is that we measured the preschoolers' overall ST and specific SBs, and used several SES indicators. We also separated the different times of the week from the accelerometer data. We therefore contributed new information on how parental SES influences engagement in specific SBs and ST in different contexts. These novel data will be useful for future interventions focusing on diminishing preschoolers' SBs.

Conclusion

The most consistent finding from this study is that overall daily screen time at home is higher among children with a low parental-educational background even at preschool age. It would therefore be valuable to develop strategies aimed at diminishing screen time at home among these children. The findings exemplify the multidimensionality of the relationship between preschoolers' SBs and parental SES. Including multiple measurements of SBs and several indicators of parental SES, and taking into account the different contexts over the course of a week (e.g. preschool, weekend) would deepen understanding of the association between SES and preschoolers' SB.

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Authors' contributions: SM drafted the manuscript and conducted the analyses of this study. HK helped in conducting the analyses and drafting the manuscript. ME, AH and ER helped in drafting the manuscript. SM, ME and E were involved in the design of the study and in seeking funding for it. R 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

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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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 children's context-specific sedentary behaviors and parental socioeconomic status: 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	4	This study examines the associations of parental SES a) with preschool children's objectively measured ST over the course of a week, and b) with preschool children's parent-reported screen and reading time at home as indicators of their SBs.
Methods				
Study design	4	Present key elements of study design early in the paper	4	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5	As part of this project 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 of participants	4-5	Parents of 983 children (27% consent rate) gave their written consent for the study. Given the recruitment criterion of including only preschools with….
		(*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	5-6	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	*5-6*	Research assistant attached accelerometer to the child's waist in the preschool. The parents received written instructions about its use. During the seven days the children were wearing the accelerometers the parents filled in a diary ….
Bias	9	Describe any efforts to address potential sources of bias	5-8	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. Once the willingness of the preschools was ascertained information letters and consent forms were distributed to parents via the respective schools…
Study size	10	Explain how the study size was arrived at	6-8	Of the 864 participating children, 17 (2%) did not want to wear the accelerometer and 20 (2%) did not return the diary. In addition, two accelerometers were not installed properly and two were not returned. We therefore had data from 821 children (95% of the participants) to be used in forming the variables…

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	5-7	The use of TV, computers, tablet computers, smartphones and DVD/Videos were combined into one variable, screen time. The weighted daily averages (5/7 on weekdays and 2/7 at weekends) of screen time and reading were calculated. No data on specific preschool-based SBs were collected
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7	The analyses were adjusted for municipality, the child's age and gender, and the season during which the accelerometer was used…
		(*b*) Describe any methods used to examine subgroups and interactions		
		(*c*) Explain how missing data were addressed	5, 7-8	Four variables with different time criteria were formed to indicate different times of the week:…
		(*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	8	The non-independence of observations due to cluster sampling (children in the preschool groups) was taken into account in the analyses, and the highest SES group was treated as a reference category…
		(*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	8	Of the 864 participating children, 17 (2%) did not want to wear the accelerometer and 20 (2%) did not return the diary. In addition, two accelerometers were not installed properly and two were not returned. We therefore had data from 821 children (95% of the participants) to be used in forming the variables…
		(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 Sample Characteristics in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland (N=864)
		(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	Table 1 Sample Characteristics in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted

				between years 2015 and 2016 in Finland (N=864)
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	9-12	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	12	In sum…
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	15	There are some limitations that should be taken into account in interpreting the results of our study. T
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15	The finding that reading and screen time had opposite relationships with parental SES attests to the necessity of measuring different types of SBs to fully understand the SES differences.
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-15	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	16	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 children's context-specific sedentary behaviors and parental socioeconomic status in Finland: a cross-sectional study

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Preschool children's context-specific sedentary behaviors and parental socioeconomic status in Finland: a cross-sectional study

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Abstract

Objectives: This study examined the associations of parental socioeconomic status (SES) a) with preschoolers' objectively measured sedentary time (SED) over the course of a week, and b) with parent-reported children's screen and reading times at home as indicators of sedentary behaviors (SB).

Design: Cross-sectional.

Setting: In years 2015 and 2016 in Finland

Participants: 864 children, aged 3-6 years, with their parents.

Outcome measures: Children's accelerometer data were transformed into average SED minutes per hour in different contexts (preschool, home during preschool days, weekend and total). Parent-reported children's screen and reading times were expressed as average daily minutes. The SES indicators (maternal and paternal education and relative household income) were grouped into three categories. Linear or logistic regression analyses were used, with municipality, season, and children's gender and age as covariates. Confidence intervals were adjusted for clustering at the preschool-group level.

Results: Children with low maternal (β=17.21, 95% CI: 8.71, 25.71) and paternal (β=10.54, 95% CI: 0.77, 20.30) education had more overall screen time at home than their more advantaged counterparts. SES differences in overall screen time were mostly explained by TV viewing. Children with low as opposed to high maternal education (β=-2.66, 95% CI: -4.95, -0.38) had less reading time at home. Children whose fathers were on the middle (β= -1.15, 95% CI: -2.01, -0.29) educational level had less weekend ~~ST~~ SED than those with high paternal education. Otherwise, parental SES was not related to objectively measured ~~ST~~ SED.

Conclusions: The results of this study highlight the fact that the associations between parental SES and preschoolers' SB are dependent on the indicators of SES and SBs, and vary between different contexts. Generally, parental SES was not associated with SED, whereas some SES differences existed in screen time and reading time at home.Interventions aiming to diminish SES differences in children's SB should focus on home hours.

Keywords: sedentary lifestyle, preschool, children,socioeconomic factors

Strengths and limitations of this study:

- The major strength of this study is that sedentary behaviors were measured using parent-reported diary and accelerometer in a relative large sample of preschool children.
- The another strength of this study is that the associations between parental socioeconomic status and children's sedentary behaviors were studied in separate contexts (e.g. preschool time, weekend).
- 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 the parent-reported diary may lead to bias in that parents might be unable to constantly monitor their children's behaviors

INTRODUCTION

Children as young as preschool age (defined here as aged 3 through 6 years) spend most of their waking hours in sedentary behaviors (SB) [1], defined as set of activities characterized by low levels of energy expenditure and a sitting or reclining position [2]. The overall sedentary time (SED) can be broken up into separate ~~(~~SB~~)~~ – of which some are more harmful to health than others. The detrimental health effects of extensive screen-based SBs, especially TV viewing, on childhood obesity, other cardiometabolic risk markers, motor-skill development, psychosocial wellbeing and cognitive development are recognized in several studies focusing on early years (roughly ages 0-5) [3-6]. On the other hand, a recent review points out the beneficial effects of reading (or being read to) for cognitive development at preschool-age [3]. There are limited indications of associations between overall objectively measured SED and health indicators among preschool children, but clearer evidence on adverse health outcomes of extensive SED has been found among adults [7-9]. The SB habits formed at the preschool-age tend to maintain throughout life-course, and track over time predicting the future SB habits and health outcomes [10-13]. Given this tracking tendency of SBs together with high levels of SB among contemporary preschool children population [1, 14], understanding of the determinants of overall SED and specific SBs is relevant for health promotion strategies.

One important factor to be studied further is parental socioeconomic status (SES). A recent review concludes that a socioeconomic gradient for many predictors of obesity is established in early childhood, and health inequalities in early childhood predict poorer health later in life

[15]. Most previous studies focus on the associations between SES and preschoolers' TV viewing, and there is concurrent evidence that preschoolers with a low SES background tend to spend more time watching TV than their counterparts with a high SES [15-17]. However, there is very little evidence with inconsistent findings of the possible SES differences in preschoolers' objectively measured SED or in other specific SBs, such as reading and other screen-related SBs [15-18]. Other SBs are known to be major contributors to preschoolers' overall SED [19], and may have different associations with indicators of SES. Similarly, different indicators of SES (e.g. education and income) may have different associations with preschoolers' SBs.

Existing studies on preschool children also tend to concentrate on weekly average SBs without considering the possible differences over the course of the week (e.g. weekdays and at weekends) or in different settings (e.g. preschool or home). For example, there may be no SES differences in children's SBs during preschool time given that early educators predetermine most behaviors and allow little flexibility. During out-of-preschool hours (later referred as home hours), parents have more an important role for planning and deciding the activities for their children. Given that SES modifies parental attitudes, experiences, and exposures to different behaviors [20-22], the behavioral variation among children may be wider at home. The results of studies conducted among school-aged children suggest that overall SED is higher after school hours and during weekends [23, 24], hence it would be relevant to find out if there are also SES differences in SED. A previous study found that preschoolers' with higher maternal education had more SED in the evenings [25]. However, specific SBs were not observed in this study, which could explicate the SES differences in overall SED. This study examines the associations of parental SES a) with preschool children's objectively measured SED over the course of a week, and b) with preschool children's parent-reported overall screen time, screen-specific time (TV viewing, computer use, DVD/video watching and tablet computer/smartphone use) and reading time at home as indicators of their SBs.

METHODS

Study design

The DAGIS (Increased Health and Wellbeing in Preschools) study is a long-term project with multiple data-collection phases [26]. As part of this project a cross-sectional study was conducted between autumn 2015 and spring 2016, the aim being to investigate socioeconomic differences in children's energy-balance-related behaviors (EBRBs). It was a multiple-method

study covering children, parents, and preschools. An ethical permit was obtained from the University of Helsinki Review Board in the Humanities and Social and Behavioral Sciences.

Study population

The cross-sectional study was conducted in eight municipalities situated in Southern and Western Finland. Municipalities in Finland are responsible for organizing preschool services based on national guidelines. Each child has a subjective right to a preschool place, and 74 percent of children aged 3-5 years are in preschool. About 76 percent of all children who are in preschools attend those organized by the municipality. [27] Only municipality-based preschools were randomly selected for the study. The main recruitment criterion for preschools was that there had to be at least one group of children aged 3-6 years in the preschool. The working language in preschool needed to be either Finnish or Swedish. We also excluded purely pre-primary education classes and preschools that are open for 24 hours a day.

Eighty-six heads of preschools (56% participation rate) gave their written consent for participation in the study. Once the willingness of the preschools was ascertained information letters and consent forms were distributed to parents via the respective schools. The main parental recruitment criterion was to have at least one child aged 3-6 years attending preschool regularly. Parents of 983 children (27% consent rate) gave their written consent for the study. Given the recruitment criterion of including only preschools with more than a 30-percent consent rate in at least one of the groups, the survey was conducted in 66 preschools, among a total of 892 children whose parents had consented to their participation. However, no research data were available on 28 children, hence the final total was 864 children (24% of those invited).

MEASURES

Indicators of sedentary behaviors

Children wore an Actigraph W-GT3X accelerometer (Actigraph, Pensacola, Florida) on the hip 24 hours a day for seven days. Actigraph has been validated and used extensively as an objective measure of physical activity (PA) and SED [28-30]. Research assistant attached accelerometer to the child's waist in the preschool. The parents received written instructions about its use. During the seven days the children were wearing the accelerometers the parents filled in a diary in which they reported their child's sleeping hours and preschool hours, non-wearing times of the accelerometer, and possible sickness days.

The epoch length was set at 15 seconds. Periods of 10 minutes or more at zero accelerometer counts were considered to be non-wearing times, and were excluded. The Evenson SED cut-point with vertical axis (≤ 100 counts per minute) was applied [31], having been shown to be a good estimate of free-living SED [32, 33]. Hours of night sleeping and reported sickness days were excluded from the analyses. Four variables with different time criteria were formed to indicate different times of the week: a) total SED time (at least 600 minutes per day, for at least four days with one weekend-day); b) preschool SED (at least 240 minutes per day, for at least two days); c) home SED during preschool days (the same days as used in the preschool variable); d) weekend SED (at least 600 minutes per day). All these variables were adjusted for the wearing hours so as to indicate the children's SED minutes in an average hour in different contexts. The presented time criteria were based on previous studies that have estimated the wearing hours and days that best illustrate preschoolers' habitual SED and PA during a whole measurement week, or in separate contexts [34-36].

The above-mentioned diary included a daily report on the children's SBs that was based on previously validated method [37]. Of the original method, only the SB section was retained. We made some modifications to the original version, asking separately about TV watching and DVD/video watching, and we added the use of tablet computers and smartphones as an option (please, see the supplementary material 1). The parents were asked to state in the diary whether their child carried out any of the listed activities while sitting down or being still. They reported daily on whether the child engaged in a certain activity, how many times and for how many hours and minutes in total. They were also asked to consider only the time periods outside preschool hours. We used the following activities from the diary in the present study: reading or looking at a book (later called reading), TV viewing ~~watching~~, DVD/video watching, computer use, tablet computer and smartphone use. The reported hours and minutes devoted to these activities were transformed into minutes. The weighted daily averages (5/7 on weekdays and 2/7 at weekends) of TV viewing, DVD/video watching, computer use, tablet computer/smartphone use and reading were calculated. The use of TV, computers, tablet computers, smartphones and DVD/Videos were combined into one variable, screen time, as well as analyzed separately. No data on specific preschool-based SBs were collected.

Indicators of socioeconomic status

The educational level of both parents was reported in the consent form: they were asked to rank their highest educational attainment on a seven-item list. The response options were re-organized into three groups: a low education was defined as comprehensive schooling

(usually from ages 7 to 16) to secondary education (usually ages 16 to 19); a medium level refers to a Bachelor's degree; and a high education as at least a Master's Degree.

Household income was elicited in the parental questionnaire. The parents were asked to report the extent of the entire household net income (after tax) on average per month, taking into account any regular income after tax such as earnings and capital gains, pensions, child benefits and other social benefits. The response options ranged from less than 500 (1), to over 10,000 (10) Euros per month. The total household net income was divided by the number of family members using a standard equivalence scale that gave a weight to all members of the household [38]. This relative household-income variable was categorized into tertiles. Low-income families had a monthly-equalized income of less than 1,894 Euros, and high-income families an income of 2,501 Euros or more.

Covariates

The analyses were adjusted for municipality, the child's age and gender, and the season during which the accelerometer was used. Parents reported the child's age and gender. Age was treated as continuous variable in the analyses. The season variable was divided into three categories: 1=September-October, 2= November-December, and 3=January-April. Both the season and the municipality variables were treated as dummy variables.

Statistical analyses

The SPSS version 23 (SPSS Inc., Chicago, IL, USA) was used to derive the descriptive statistics. Screen time (N=4) and home SED (N=1) had outliers beyond three standard deviations of the mean, and were thus removed from the analyses.

Linear regression analyses were conducted to examine the associations between the SES indicators and each ~~SB~~ SED variable, overall screen time, and reading time. Logistic regression analyses were conducted to examine the associations between the SES indicators and TV viewing, DVD/video watching, computer use and tablet computer/smart phone use. These four variables were dichotomized for logistic regression analyses so that children with highest 25 percent of using/viewing time were compared to other children. Mplus Version 7.4. (Muthen & Muthen, Los Angeles, CA, USA) with Maximum Likelihood Estimation and Robust Standard Errors (MLR) was used to perform linear and logistic regression analyses. The non-independence of observations due to cluster sampling (children in the preschool groups) was taken into account in the analyses, and the highest SES group was treated as a reference category.

RESULTS

Of the 864 participating children, 17 (2%) did not want to wear the accelerometer and 20 (2%) did not return the diary. In addition, two accelerometers were not installed properly and two were not returned. We therefore had data from 821 children (95% of the participants) to be used in forming the variables. In accordance with the criteria presented above, between 772 and 789 children had produced the required amount of accelerometer data for the analyses. Those who did not produce valid accelerometer data for total time and weekend SED were more likely to have a mother with a lower level of education than those who produced valid accelerometer data (data not shown). The overall average of daily wearing time was 773 minutes. A total of 771 parents filled in the diary properly. There were no differences in SES indicators between those who produced valid or invalid diary data. Parent-reported daily screen time correlated positively with objectively measured home SED (r=0.95, P=0.010) and with weekend SED (r=0.92, P=0.013), but negatively with preschool SED (r=-0.14, P<0.001). Reading did not correlate with any other outcomes. TV viewing correlated with preschool SED (r=-.08, P=0.05), weekend SED (r=.13, P=0.001), and total SED (r=.08, P=0.05). Tablet computer/smartphone use correlated with preschool SED (r=-.14, P<0.001), home SED (r=.17, P<0.001), weekend SED (r=.14, P<0.001), and total SED (r=.08, P=.05). Maternal education correlated with paternal education (r=0.49, P<0.001) and relative household income (r=0.31, P<0.001), and paternal education correlated with relative household income (r=0.32, P<0.001). Sample characteristics of the participants are described in Table 1.

Table 1 Sample Characteristics in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland (N=864)

Measure		Value [1]	N
Children's age		4.73 (.89)	864
Children's gender			
	Girls	48%	413
	Boys	52%	450
Season during which the accelerometer was worn			
	September-October	44%	354
	November-December	36%	290
	January-April	20%	164
Maternal education			
	Low (1)	30%	265
	Medium (2)	41%	358
	High (3)	29%	256
Paternal education			
	Low (1)	45%	365
	Medium (2)	33%	267
	High (3)	22%	181
Household income			
	Low (1)	32%	224
	Medium (2)	34%	232
	High (3)	34%	235
Children's sedentary time measured by the accelerometer (min/hour)			
	Total time	28.11 (4.01)	772
	Preschool	26.47 (5.11)	778
	Home time in preschool days	29.74 (4.96)	777
	Weekend	28.47 (4.76)	779
Children's sedentary time			

measured in the diary (min/day)

Screen time	111.02 (48.50)	767
TV viewing	56.14 (28.20)	771
Computer use	9.06 (20.32)	771
Tablet/smart phone use	21.82 (26.18)	771
DVD/video watching	25.66 (30.50)	771
Reading	19.19 (11.35)	765

[1] Values are mean (Standard Deviation) unless otherwise stated. N=864

Table 2 presents the results on the associations of maternal education, paternal education, and relative household income with objectively measured preschool children's SED in different contexts. According to the findings, children whose fathers had a medium as opposed to a high level of education had, on average, 1.2 minutes (95% CI: -2.01, -0.29) less weekend SED per hour.

Table 2. The associations between parental socioeconomic status and preschool children's objectively measured sedentary time (minutes/hour) over the course of the week measured by means of linear regression models, adjusted for municipality, season, and the children's gender and age in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland

Socioeconomic status Indicator	Sedentary time in preschool			Home sedentary time in preschool days			Sedentary time in weekends			Total sedentary time		
	β	Lower 95% CI	Higher 95% CI	B	Lower 95 % CI	Higher 95% CI	β	Lower 95% CI	Higher 95% CI	β	Lower 95% CI	Higher 95% CI
Maternal education (N between 738 – 744)												
Low	0.46	-0.45	1.36	0.47	-0.53	1.47	-0.09	-0.71	0.90	0.33	-0.35	1.00
Medium	-0.53	-1.37	0.31	0.44	-0.28	1.17	-0.17	-0.94	0.59	-0.22	-0.83	0.40
High (reference)												
Paternal education (N between 682 – 691)												
Low	-0.17	-1.14	0.79	0.05	-0.86	0.96	-0.49	-1.25	0.27	-0.02	-0.68	0.63
Medium	-0.28	-1.28	0.72	0.10	-0.78	0.99	-1.15	-2.01	-0.29	-0.46	-1.10	0.18
High (reference)												
Household income (N between 639 – 646)												
Low	0.47	-0.34	1.28	-0.85	-1.76	0.06	-0.52	-1.27	0.24	-0.11	-0.74	0.51
Medium	-0.34	-1.16	0.49	-0.22	-0.99	0.54	-0.05	-0.83	0.73	-0.13	-0.69	0.44
High (reference)												

Table 3 presents the results on the associations of maternal education, paternal education, and relative household income with their children's daily overall screen time and reading time at home. Compared to children whose mothers had a high level of education, those with a low or a medium level of maternal education had, respectively and on average, 17.21 (95% CI: 8.71, 25.71) and 11.17 (95% CI: 3.69, 18.64) minutes more screen time daily. Children whose fathers had a low level of education had 10.54 (95% CI: 0.77, 20.30) minutes more screen time than their counterparts with high paternal education. Children whose mothers had a low level of education had, on average, 2.66 (95% CI: -4.95, -0.38) minutes less reading time daily than their counterparts with high maternal education.

Table 3. The associations between parental socioeconomic status and preschool children's daily average screen and reading time at home measured by means of linear regression analysis, and adjusted for municipality, season, and the children's gender and age in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland

Socioeconomic status	Daily screen time at home (min/day)			Daily reading time at home (min/day)		
Indicator	β	Lower 95% CI	Higher 95% CI	β	Lower 95% CI	Higher 95% CI
Maternal education (N between 726 – 728)						
Low	17.21	8.71	25.71	-2.66	-4.95	-0.38
Medium	11.17	3.69	18.64	-1.82	-3.79	0.15
High (reference)						
Paternal education (N between 674 – 676)						
Low	10.54	0.77	20.30	-2.31	-4.85	0.23
Medium	-1.17	-11.07	8.74	-1.66	-4.32	0.99
High (reference)						
Household income (N=628)						
Low	9.82	-0.13	19.78	-1.34	-3.60	0.92
Medium	6.60	-2.41	15.60	0.14	-2.07	2.34
High (reference)						

Table 4 presents the results on the associations of maternal education, paternal education, and relative household income with their children's TV viewing, computer use, DVD/video watching, and smartphone/tablet computer use. Compared to children whose mothers had a high level of education, those with a low or middle level of maternal education had a significantly increased risk of viewing TV over 72 minutes per day with the highest risk in the group with the lowest educated mothers (OR in low educated group: 2.59, 95% CI 1.58, 4.26; OR in middle educated group: 2.00, 95% CI 1.22, 3.27). Children whose fathers had a low level of education had an increased risk of viewing TV over 72 minutes day (OR: 1.96, 95% CI 1.21, 3.15) compared to their counterparts with a high paternal education. Compared to children who had a high level of household income, those with a low or middle level of household income had an elevated risk of viewing TV over 72 minutes per day with the highest risk in the group with the lowest income (OR in the low income group: 1.74, 95% CI: 1.05, 2.87; OR in the middle income group: 1.64, 95% CI 1.00, 2.69).

Finally, children whose family had a middle level of household income had a higher risk of watching DVD/videos over 44 minutes per day (OR: 1.68, 95% CI: 1.05, 2.68) and a lower risk of using tablet computers/smartphones over 33 minutes per day (OR: 0.53, 95% CI: 0.33, 0.84) compared to their counterparts with a high household income.

Table 4. The associations between parental socioeconomic status and preschool children's daily average TV viewing, computer use, DVD/video watching and smartphone/tablet computer use measured by means of logistic regression analysis, and adjusted for municipality, season, and the children's gender and age in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland [1]

Socioeconomic status	TV viewing at home (over 72 minutes per day)[2]			Computer use at home (over 1 minute per day)[2]			DVD/video watching at home (over 44 minutes per day)[2]			Smartphone/tablet computer use (over 33 minutes per day)[2]		
Indicator	OR	Lower 95% CI	Higher 95% CI	OR	Lower 95% CI	Higher 95% CI	OR	Lower 95% CI	Higher 95% CI	OR	Lower 95% CI	Higher 95% CI
Maternal education (N =731)												
Low	2.59	1.58	4.26	1.14	0.77	1.68	1.12	0.68	1.84	0.98	0.61	1.59
Medium	2.00	1.22	3.27	0.67	0.45	1.02	1.27	0.80	2.00	1.38	0.92	2.06
High (reference)												
Paternal education (N= 679)												
Low	1.96	1.21	3.15	1.19	0.80	1.78	0.97	0.60	1.58	0.79	0.49	1.26
Medium	1.13	0.67	1.90	1.02	0.64	1.63	0.70	0.42	1.16	1.00	0.63	1.58
High (reference)												
Household income (N=630)												
Low	1.74	1.05	2.87	1.31	0.87	1.97	1.52	0.93	2.50	0.71	0.43	1.18
Medium	1.64	1.00	2.69	1.23	0.79	1.92	1.68	1.05	2.68	0.53	0.33	0.84
High (reference)												

[1] Values are odds ratios (95% confidence intervals)

[2] The highest 25% of parental reported children's screen-specific time in minutes per day (1) was compared to others

DISCUSSION

The main findings of this study show that children with low parental education had more overall screen time at home than their counterparts with highly educated parents, whereas those whose mothers had a higher as opposed to a lower level of education had more reading time. Screen-specific (TV viewing, DVD/video watching, computer use and tablet computer/smartphone use) analyses indicated that SES differences in overall screen time were mostly explained by TV viewing. Otherwise, parental SES was mainly unrelated to the children's objectively measured SED over the course of the week.

In our study, preschoolers with lower parental education had between 10 (paternal education) and 17 (maternal education) minutes more daily screen time at home than their counterparts with higher parental education. Especially, the children with lower SES backgrounds had an increased risk of viewing TV over 72 minutes per day, compared to children with higher SES backgrounds. Our results support therefore findings of other studies that conclude preschool children with low SES backgrounds tend to have higher risks to exceed the screen time recommendations [39-41]. However, a recent meta-analysis reports that the associations of SES and children's SB are dependent on the country so that SES is inversely associated especially with screen time and TV viewing time in high-income countries whereas SES is positively associated with 'other' screen time such as computers and videos in low-middle-income countries [42]. The clinical relevance of a 10 to 17 minutes educational difference in screen time at home requires further evaluation. The result, however, has public health importance when developing the strategies to diminishing socioeconomic gradient in preschool children's screen time.

Different types of screens have become part of everyday life in families with preschoolers, and controlling screen use may be difficult for parents. Higher as opposed to lower parental education is usually related to enhanced awareness, capabilities and skills in terms of adopting a healthy lifestyle [21]. Screen-time reduction may require additional resources (e.g. financial, time) that parents are not necessarily able to provide, which in turn could add to parental stress [43, 44]. Stress in combination with a lack of resources might make it challenging for parents with a low educational level to limit screen time among their children. Previous studies suggest that parents with lower SES backgrounds have less rules related to TV viewing, allow TV viewing more often, and view TV together with their child more frequently [22, 44, 45]. Other studies suggest that in general, parents might have strict screen

time rules for their children, but parents who are high screen users themselves more often fail to follow these rules and have joint screen time more frequently [46-50]. Parental rules and restrictions around children's screen time may therefore be important factor to focus in future interventions aiming to diminish SES gradient in children's screen time. Another potential factor may be the parental perceptions of suitable screen time for children [51], although possible SES differences in parental perceptions is less clear. The tighter norm for suitable children's screen time could mean tighter rules and restrictions around children's screen time. However, parental perceptions of the suitable amount of screen time as intervention strategy has not previously been used in interventions focusing on preschool children's screen time[52], although successful changes have been achieved in other health behavior interventions focusing on changing norms[53]. More study is anyhow needed to explore the potential factors acting as mediators in the associations between parental SES and children's screen time. Such information may help target and design more effective family-based interventions aiming to diminish socioeconomic gradient in children's screen time.

Parents seem to value optimal cognitive development during early childhood [54]. Previous studies have illustrated that parents of preschool-aged children consider screen-time activities to be good educational tools, whereas the detrimental effects of extensive screen time on cognitive development is not mentioned [55-58]. These studies have not taken possible SES differences into consideration. Parents with a higher level of education might realize the harmful health effects of increased screen time and place more value on their children's educational achievements, and therefore encourage them to spend more time with books instead of watching a screen. It may be that parents with a low educational background do not realize the detrimental effects of screen time on cognitive development, and place more value on the educational aspects. Still, it should be acknowledged that some aspects of screen time could be educational. Applications in touch-screen devices such as tablet computers and smart phones are being used to an increasing extent as learning tools in preschools, for example. However, there is little current research about the real educational benefits of using these tools [59]. The results of some studies suggest that the use of touch-screen devices inhibits social interaction and children's ability to self-regulate their behavior, although benefits related to early literacy skills, the stimulation of concentration and the fostering of independent learning are also acknowledged [59]. Nevertheless, screen time is usually sedentary in nature, and it is therefore important to limit its use.

The finding that reading and screen time had opposite relationships with parental SES attests to the necessity of measuring different types of SBs to fully understand the SES differences. SES differences in reading time in early childhood are seldom addressed in SB studies, for example, although its beneficial influences on cognitive development and school readiness are recognized [3, 60]. These contradictory SES associations with different types of SBs could also partly explain the few associations between overall objectively measured SED and indicators of SES found in this study. It would therefore be relevant to consider whether it might be more worthwhile focusing on the type of SB than overall SED in research on SES differences in children's SB. Similarly, the wide variation of screens currently available ensures variation in the way they are used. Tablet computers and mobile devices are used not only as behavioral-control tools to calm down or distract children in restaurants and cars, but also for educational purposes [43, 59, 61]. It may be worth considering the context in which the devices are used in future studies, as well as potential SES differences in the way they are used.

We did not find any SES differences in SED during preschool hours: to our knowledge, no other studies have addressed this issue. However, our finding is inconsistent with a previous study on school-aged children reporting that offspring with parents educated to university level or higher had less SED in schools than children with less highly educated parents [62]. The school setting with its compulsory lessons is different than the preschool setting, however. The Finnish preschool model is based on learning by playing, and compulsory pre-primary education in preparation for official schooling starts at the age of six [63]. We excluded pre-primary education classes during the recruitment phase of the DAGIS study. However, we did not measure children's specific SBs during preschool hours in more detail: we thought it would be too time-consuming to list specific SBs in diaries for each child in the preschool group. According to our preparatory work before we conducted this cross-sectional survey, the availability of screens in Finnish preschools is limited [64]. More research is therefore needed to shed light on the role of preschools in balancing SES differences in children's SB. Future studies could compare the associations between SES and SB among children who are attending preschool and those who are mainly cared for at home, for example.

There are some limitations that should be taken into account in interpreting the results of our study. The DAGIS study is cross-sectional, and therefore the causality between parental SES and children's SB cannot be fully established. The participation rate of families was low,

which may influence the generalizability of our findings. It might be that a selected sample of participants from preschools participated in this study. Similarly, children who did not produce valid accelerometer data for total time (6 %) and weekend SED (5 %) were more likely to have a mother with a lower level of education suggesting that included children are not representative of the overall study population. There are several accelerometer cut-points for SED among preschool children, and there is no consensus as to which are the most suitable. However, the results of ~~a recent comparative study~~ a comparative study among 4-6 years old children support the choice of Evenson cut-points for measuring SED [28]. Moreover, the hip-worn accelerometer might not give the most accurate measurements because it does not effectively separate standing from sitting and reclining positions [32]. The information on children's screen time and reading was based on parental reports, and as with any other reported information, proxy reports may lead to bias in that parents might be unable to constantly monitor their children's behaviors [65, 66]. In addition, parents might have under- or over-reported in socially desirable manner the children's screen time and reading time. Nevertheless, the diary is generally considered to be more reliable than a few items in a questionnaire [67]. A major strength of this study is that it encompasses a large sample, including children from 66 different preschools in various municipalities. Another strength is that we measured the preschoolers' overall SED and specific SBs, and used several SES indicators. We also separated the different times of the week from the accelerometer data. We therefore contributed new information on how parental SES influences engagement in specific SBs and SED in different contexts. These novel data will be useful for future interventions focusing on diminishing preschoolers' SBs.

Conclusion

The most consistent finding from this study is that overall daily screen time at home is higher among children with a low parental-educational background even at preschool age. It would therefore be valuable to develop strategies aimed at diminishing screen time at home among these children. The findings exemplify the multidimensionality of the relationship between preschoolers' SBs and parental SES. Including multiple measurements of SBs and several indicators of parental SES, and taking into account the different contexts over the course of a week (e.g. preschool, weekend) would deepen understanding of the association between SES and preschoolers' SB.

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Supplementary material. The example of parent-reported diary measuring preschool children's screen time and reading time in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland

Day X

The date:

__/___/2015

Did your child do any of the following activities today in sitting or being still?

	YES	NO	Times	Total time (h/min)
1. Television viewing	○	○		
2. DVD's or videos watching	○	○		
3. Tablet computer or smart phone use	○	○		
4. Computer use or playing computer games	○	○		
6. Reading or being read to or looking at books	○	○		

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 children's context-specific sedentary behaviors and parental socioeconomic status: 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	4	This study examines the associations of parental SES a) with preschool children's objectively measured ST over the course of a week, and b) with preschool children's parent-reported screen and reading time at home as indicators of their SBs.
Methods				
Study design	4	Present key elements of study design early in the paper	4	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5	As part of this project 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 of participants	4-5	Parents of 983 children (27% consent rate) gave their written consent for the study. Given the recruitment criterion of including only preschools with….
		(*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	5-6	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	*5-6*	Research assistant attached accelerometer to the child's waist in the preschool. The parents received written instructions about its use. During the seven days the children were wearing the accelerometers the parents filled in a diary ….
Bias	9	Describe any efforts to address potential sources of bias	5-8	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. Once the willingness of the preschools was ascertained information letters and consent forms were distributed to parents via the respective schools…
Study size	10	Explain how the study size was arrived at	6-8	Of the 864 participating children, 17 (2%) did not want to wear the accelerometer and 20 (2%) did not return the diary. In addition, two accelerometers were not installed properly and two were not returned. We therefore had data from 821 children (95% of the participants) to be used in forming the variables…

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	5-7	The use of TV, computers, tablet computers, smartphones and DVD/Videos were combined into one variable, screen time. The weighted daily averages (5/7 on weekdays and 2/7 at weekends) of screen time and reading were calculated. No data on specific preschool-based SBs were collected
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7	The analyses were adjusted for municipality, the child's age and gender, and the season during which the accelerometer was used…
		(*b*) Describe any methods used to examine subgroups and interactions		
		(*c*) Explain how missing data were addressed	5, 7-8	Four variables with different time criteria were formed to indicate different times of the week:…
		(*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	8	The non-independence of observations due to cluster sampling (children in the preschool groups) was taken into account in the analyses, and the highest SES group was treated as a reference category…
		(*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	8	Of the 864 participating children, 17 (2%) did not want to wear the accelerometer and 20 (2%) did not return the diary. In addition, two accelerometers were not installed properly and two were not returned. We therefore had data from 821 children (95% of the participants) to be used in forming the variables…
		(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 Sample Characteristics in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland (N=864)
		(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	Table 1 Sample Characteristics in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted

				between years 2015 and 2016 in Finland (N=864)
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	9-12	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	12	In sum…
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	15	There are some limitations that should be taken into account in interpreting the results of our study. T
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15	The finding that reading and screen time had opposite relationships with parental SES attests to the necessity of measuring different types of SBs to fully understand the SES differences.
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-15	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	16	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 children's context-specific sedentary behaviors and parental socioeconomic status in Finland: a cross-sectional study

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Preschool children's context-specific sedentary behaviors and parental socioeconomic status in Finland: a cross-sectional study

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Abstract

Objectives: This study examined the associations of parental socioeconomic status (SES) a) with preschoolers' objectively measured sedentary time (SED) over the course of a week, and b) with parent-reported children's screen and reading times at home as indicators of sedentary behaviors (SB).

Design: Cross-sectional.

Setting: In years 2015 and 2016 in Finland

Participants: 864 children, aged 3-6 years, with their parents.

Outcome measures: Children's accelerometer data were transformed into average SED minutes per hour in different contexts (preschool, home during preschool days, weekend and total). Parent-reported children's screen and reading times were expressed as average daily minutes. The SES indicators (maternal and paternal education and relative household income) were grouped into three categories. Linear or logistic regression analyses were used, with municipality, season, and children's gender and age as covariates. Confidence intervals were adjusted for clustering at the preschool-group level.

Results: Children with low maternal (β=17.21, 95% CI: 8.71, 25.71) and paternal (β=10.54, 95% CI: 0.77, 20.30) education had more overall screen time at home than their more advantaged counterparts. SES differences in overall screen time were mostly explained by TV viewing. Children with low as opposed to high maternal education (β=-2.66, 95% CI: -4.95, -0.38) had less reading time at home. Children whose fathers were on the middle (β= -1.15, 95% CI: -2.01, -0.29) educational level had less weekend SED than those with high paternal education. Otherwise, parental SES was not related to objectively measured ~~ST~~ SED.

Conclusions: The results of this study highlight the fact that the associations between parental SES and preschoolers' SB are dependent on the indicators of SES and SBs, and vary between different contexts. Generally, parental SES was not associated with SED, whereas some SES differences existed in screen time and reading time at home. Interventions aiming to diminish SES differences in children's SB should focus on home hours.

Keywords: sedentary lifestyle, preschool, children,socioeconomic factors

Strengths and limitations of this study:

- The major strength of this study is that sedentary behaviors were measured using parent-reported diary and accelerometer in a relative large sample of preschool children.
- The another strength of this study is that the associations between parental socioeconomic status and children's sedentary behaviors were studied in separate contexts (e.g. preschool time, weekend).
- 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 the parent-reported diary may lead to bias in that parents might be unable to constantly monitor their children's behaviors

INTRODUCTION

Children as young as preschool age (defined here as aged 3 through 6 years) spend most of their waking hours in sedentary behaviors (SB) [1], defined as set of activities characterized by low levels of energy expenditure and a sitting or reclining position [2]. The overall sedentary time (SED) can be broken up into separate SB – of which some are more harmful to health than others. The detrimental health effects of extensive screen-based SBs, especially TV viewing, on childhood obesity, other cardiometabolic risk markers, motor-skill development, psychosocial wellbeing and cognitive development are recognized in several studies focusing on early years (roughly ages 0-5) [3-6]. On the other hand, a recent review points out the beneficial effects of reading (or being read to) for cognitive development at preschool-age [3]. There are limited indications of associations between overall objectively measured SED and health indicators among preschool children, but clearer evidence on adverse health outcomes of extensive SED has been found among adults [7-9]. The SB habits formed at the preschool-age tend to maintain throughout life-course, and track over time predicting the future SB habits and health outcomes [10-13]. Given this tracking tendency of SBs together with high levels of SB among contemporary preschool children population [1, 14], understanding of the determinants of overall SED and specific SBs is relevant for health promotion strategies.

One important factor to be studied further is parental socioeconomic status (SES). A recent review concludes that a socioeconomic gradient for many predictors of obesity is established

in early childhood, and health inequalities in early childhood predict poorer health later in life [15]. Most previous studies focus on the associations between SES and preschoolers' TV viewing, and there is concurrent evidence that preschoolers with a low SES background tend to spend more time watching TV than their counterparts with a high SES [15-17]. However, there is very little evidence with inconsistent findings of the possible SES differences in preschoolers' objectively measured SED or in other specific SBs, such as reading and other screen-related SBs [15-18]. Other SBs are known to be major contributors to preschoolers' overall SED [19], and may have different associations with indicators of SES. Similarly, different indicators of SES (e.g. education and income) may have different associations with preschoolers' SBs.

Existing studies on preschool children also tend to concentrate on weekly average SBs without considering the possible differences over the course of the week (e.g. weekdays and at weekends) or in different settings (e.g. preschool or home). For example, there may be no SES differences in children's SBs during preschool time given that early educators predetermine most behaviors and allow little flexibility. During out-of-preschool hours (later referred as home hours), parents have more an important role for planning and deciding the activities for their children. Given that SES modifies parental attitudes, experiences, and exposures to different behaviors [20-22], the behavioral variation among children may be wider at home. The results of studies conducted among school-aged children suggest that overall SED is higher after school hours and during weekends [23,24], hence it would be relevant to find out if there are also SES differences in SED. A previous study found that preschoolers' with higher maternal education had more SED in the evenings [25]. However, specific SBs were not observed in this study, which could explicate the SES differences in overall SED. This study examines the associations of parental SES a) with preschool children's objectively measured SED over the course of a week, and b) with preschool children's parent-reported overall screen time, screen-specific time (TV viewing, computer use, DVD/video watching and tablet computer/smartphone use) and reading time at home as indicators of their SBs.

METHODS

Study design

The DAGIS (Increased Health and Wellbeing in Preschools) study is a long-term project with multiple data-collection phases [26]. As part of this project a cross-sectional study was conducted between autumn 2015 and spring 2016, the aim being to investigate socioeconomic

differences in children's energy-balance-related behaviors (EBRBs). It was a multiple-method study covering children, parents, and preschools. An ethical permit was obtained from the University of Helsinki Review Board in the Humanities and Social and Behavioral Sciences.

Study population

The cross-sectional study was conducted in eight municipalities situated in Southern and Western Finland. Municipalities in Finland are responsible for organizing preschool services based on national guidelines. Each child has a subjective right to a preschool place, and 74 percent of children aged 3-5 years are in preschool. About 76 percent of all children who are in preschools attend those organized by the municipality[27]. Only municipality-based preschools were randomly selected for the study. The main recruitment criterion for preschools was that there had to be at least one group of children aged 3-6 years in the preschool. The working language in preschool needed to be either Finnish or Swedish. We also excluded purely pre-primary education classes and preschools that are open for 24 hours a day.

Eighty-six heads of preschools (56% participation rate) gave their written consent for participation in the study. Once the willingness of the preschools was ascertained information letters and consent forms were distributed to parents via the respective schools. The main parental recruitment criterion was to have at least one child aged 3-6 years attending preschool regularly. Parents of 983 children (27% consent rate) gave their written consent for the study. Given the recruitment criterion of including only preschools with more than a 30-percent consent rate in at least one of the groups, the survey was conducted in 66 preschools, among a total of 892 children whose parents had consented to their participation. However, no research data were available on 28 children, hence the final total was 864 children (24% of those invited).

MEASURES

Indicators of sedentary behaviors

Children wore an Actigraph W-GT3X accelerometer (Actigraph, Pensacola, Florida) on the hip 24 hours a day for seven days. Actigraph has been validated and used extensively as an objective measure of physical activity (PA) and SED [28-30]. Research assistant attached accelerometer to the child's waist in the preschool. The parents received written instructions about its use. During the seven days the children were wearing the accelerometers the parents

filled in a diary in which they reported their child's sleeping hours and preschool hours, non-wearing times of the accelerometer, and possible sickness days.

The epoch length was set at 15 seconds. Periods of 10 minutes or more at zero accelerometer counts were considered to be non-wearing times, and were excluded. The Evenson SED cut-point with vertical axis (≤ 100 counts per minute) was applied [31], having been shown to be a good estimate of free-living SED [32, 33]. Hours of night sleeping and reported sickness days were excluded from the analyses. Four variables with different time criteria were formed to indicate different times of the week: a) total SED time (at least 600 minutes per day, for at least four days with one weekend-day); b) preschool SED (at least 240 minutes per day, for at least two days); c) home SED during preschool days (the same days as used in the preschool variable); d) weekend SED (at least 600 minutes per day). All these variables were adjusted for the wearing hours so as to indicate the children's SED minutes in an average hour in different contexts. The presented time criteria were based on previous studies that have estimated the wearing hours and days that best illustrate preschoolers' habitual SED and PA during a whole measurement week, or in separate contexts [34-36].

The above-mentioned diary included a daily report on the children's SBs that was based on previously validated method [37]. Of the original method, only the SB section was retained. We made some modifications to the original version, asking separately about TV watching and DVD/video watching, and we added the use of tablet computers and smartphones as an option (please, see the supplementary material 1). The parents were asked to state in the diary whether their child carried out any of the listed activities while sitting down or being still. They reported daily on whether the child engaged in a certain activity, how many times and for how many hours and minutes in total. They were also asked to consider only the time periods outside preschool hours. We used the following activities from the diary in the present study: reading or looking at a book (later called reading), TV viewing, DVD/video watching, computer use, tablet computer and smartphone use. The reported hours and minutes devoted to these activities were transformed into minutes. The weighted daily averages (5/7 on weekdays and 2/7 at weekends) of TV viewing, DVD/video watching, computer use, tablet computer/smartphone use and reading were calculated. The use of TV, computers, tablet computers, smartphones and DVD/Videos were combined into one variable, screen time, as well as analyzed separately. No data on specific preschool-based SBs were collected.

Indicators of socioeconomic status

The educational level of both parents was reported in the consent form: they were asked to rank their highest educational attainment on a seven-item list. The response options were re-organized into three groups: a low education was defined as comprehensive schooling (usually from ages 7 to 16) to secondary education (usually ages 16 to 19); a medium level refers to a Bachelor's degree; and a high education as at least a Master's Degree.

Household income was elicited in the parental questionnaire. The parents were asked to report the extent of the entire household net income (after tax) on average per month, taking into account any regular income after tax such as earnings and capital gains, pensions, child benefits and other social benefits. The response options ranged from less than 500 (1), to over 10,000 (10) Euros per month. The total household net income was divided by the number of family members using a standard equivalence scale that gave a weight to all members of the household [38]. This relative household-income variable was categorized into tertiles. Low-income families had a monthly-equalized income of less than 1,894 Euros, and high-income families an income of 2,501 Euros or more.

Covariates

The analyses were adjusted for municipality, the child's age and gender, and the season during which the accelerometer was used. Parents reported the child's age and gender. Age was treated as continuous variable in the analyses. The season variable was divided into three categories: 1=September-October, 2= November-December, and 3=January-April. Both the season and the municipality variables were treated as dummy variables.

Statistical analyses

The SPSS version 23 (SPSS Inc., Chicago, IL, USA) was used to derive the descriptive statistics. Screen time (N=4) and home SED (N=1) had outliers beyond three standard deviations of the mean, and were thus removed from the analyses.

Linear regression analyses were conducted to examine the associations between the SES indicators and each SED variable, overall screen time, and reading time. Logistic regression analyses were conducted to examine the associations between the SES indicators and TV viewing, DVD/video watching, computer use and tablet computer/smart phone use. Due to non-normal distribution, these four variables were dichotomized for logistic regression analyses so that children with highest 25 percent of using/viewing time were compared to other children. Mplus Version 7.4. (Muthen & Muthen, Los Angeles, CA, USA) with Maximum Likelihood Estimation and Robust Standard Errors (MLR) was used to perform

linear and logistic regression analyses. The non-independence of observations due to cluster sampling (children in the preschool groups) was taken into account in the analyses, and the highest SES group was treated as a reference category. After all the linear and logistic regression analyses were conducted, Benjamini-Hochberg procedure was carried out for the obtained p-values to control the false discovery rate [39]. The significance level was established at $p<0.05$ and the false discovery rate was 0.25.

RESULTS

Of the 864 participating children, 17 (2%) did not want to wear the accelerometer and 20 (2%) did not return the diary. In addition, two accelerometers were not installed properly and two were not returned. We therefore had data from 821 children (95% of the participants) to be used in forming the variables. In accordance with the criteria presented above, between 772 and 789 children had produced the required amount of accelerometer data for the analyses. Those who did not produce valid accelerometer data for total time and weekend SED were more likely to have a mother with a lower level of education than those who produced valid accelerometer data (data not shown). The overall average of daily wearing time was 773 minutes. A total of 771 parents filled in the diary properly. There were no differences in SES indicators between those who produced valid or invalid diary data. Parent-reported daily screen time correlated positively with objectively measured home SED (r=0.95, P=0.010) and with weekend SED (r=0.92, P=0.013), but negatively with preschool SED (r=-0.14, P<0.001). Reading did not correlate with any other outcomes. TV viewing correlated with preschool SED (r=-.08, P=0.05), weekend SED (r=.13, P=0.001), and total SED (r=.08, P=0.05). Tablet computer/smartphone use correlated with preschool SED (r=-.14, P<0.001), home SED (r=.17, P<0.001), weekend SED (r=.14, P<0.001), and total SED (r=.08, P=.05). Maternal education correlated with paternal education (r=0.49, P<0.001) and relative household income (r=0.31, P<0.001), and paternal education correlated with relative household income (r=0.32, P<0.001). Sample characteristics of the participants are described in Table 1.

Table 1 Sample Characteristics in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland (N=864)

Measure		Value [1]	N
Children's age		4.73 (.89)	864
Children's gender			
	Girls	48%	413
	Boys	52%	450
Season during which the accelerometer was worn			
	September-October	44%	354
	November-December	36%	290
	January-April	20%	164
Maternal education			
	Low (1)	30%	265
	Medium (2)	41%	358
	High (3)	29%	256
Paternal education			
	Low (1)	45%	365
	Medium (2)	33%	267
	High (3)	22%	181
Household income			
	Low (1)	32%	224
	Medium (2)	34%	232
	High (3)	34%	235
Children's sedentary time measured by the accelerometer (min/hour)			
	Total time	28.11 (4.01)	772
	Preschool	26.47 (5.11)	778
	Home time in preschool days	29.74 (4.96)	777
	Weekend	28.47 (4.76)	779
Children's sedentary time			

measured in the diary (min/day)		
Screen time	111.02 (48.50)	767
TV viewing	56.14 (28.20)	771
Computer use	9.06 (20.32)	771
Tablet/smart phone use	21.82 (26.18)	771
DVD/video watching	25.66 (30.50)	771
Reading	19.19 (11.35)	765

[1] Values are mean (Standard Deviation) unless otherwise stated. N=864

Table 2 presents the results on the associations of maternal education, paternal education, and relative household income with objectively measured preschool children's SED in different contexts. According to the findings, children whose fathers had a medium as opposed to a high level of education had, on average, 1.2 minutes (95% CI: -2.01, -0.29) less weekend SED per hour.

Table 2. The associations between parental socioeconomic status and preschool children's objectively measured sedentary time (minutes/hour) over the course of the week measured by means of linear regression models, adjusted for municipality, season, and the children's gender and age in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland

Socioeconomic status Indicator	Sedentary time in preschool			Home sedentary time in preschool days			Sedentary time in weekends			Total sedentary time		
	β	Lower 95% CI	Higher 95% CI	B	Lower 95 % CI	Higher 95% CI	β	Lower 95% CI	Higher 95% CI	β	Lower 95% CI	Higher 95% CI
Maternal education (N between 738 – 744)												
Low	0.46	-0.45	1.36	0.47	-0.53	1.47	-0.09	-0.71	0.90	0.33	-0.35	1.00
Medium	-0.53	-1.37	0.31	0.44	-0.28	1.17	-0.17	-0.94	0.59	-0.22	-0.83	0.40
High (reference)												
Paternal education (N between 682 – 691)												
Low	-0.17	-1.14	0.79	0.05	-0.86	0.96	-0.49	-1.25	0.27	-0.02	-0.68	0.63
Medium	-0.28	-1.28	0.72	0.10	-0.78	0.99	-1.15	-2.01	-0.29	-0.46	-1.10	0.18
High (reference)												
Household income (N between 639 – 646)												
Low	0.47	-0.34	1.28	-0.85	-1.76	0.06	-0.52	-1.27	0.24	-0.11	-0.74	0.51
Medium	-0.34	-1.16	0.49	-0.22	-0.99	0.54	-0.05	-0.83	0.73	-0.13	-0.69	0.44
High (reference)												

Table 3 presents the results on the associations of maternal education, paternal education, and relative household income with their children's daily overall screen time and reading time at home. Compared to children whose mothers had a high level of education, those with a low or a medium level of maternal education had, respectively and on average, 17.21 (95% CI: 8.71, 25.71) and 11.17 (95% CI: 3.69, 18.64) minutes more screen time daily. Children whose fathers had a low level of education had 10.54 (95% CI: 0.77, 20.30) minutes more screen time than their counterparts with high paternal education. Children whose mothers had a low level of education had, on average, 2.66 (95% CI: -4.95, -0.38) minutes less reading time daily than their counterparts with high maternal education.

Table 3. The associations between parental socioeconomic status and preschool children's daily average screen and reading time at home measured by means of linear regression analysis, and adjusted for municipality, season, and the children's gender and age in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland

Socioeconomic status	Daily screen time at home (min/day)			Daily reading time at home (min/day)		
Indicator	β	Lower 95% CI	Higher 95% CI	β	Lower 95% CI	Higher 95% CI
Maternal education (N between 726 – 728)						
Low	17.21	8.71	25.71	-2.66	-4.95	-0.38
Medium	11.17	3.69	18.64	-1.82	-3.79	0.15
High (reference)						
Paternal education (N between 674 – 676)						
Low	10.54	0.77	20.30	-2.31	-4.85	0.23
Medium	-1.17	-11.07	8.74	-1.66	-4.32	0.99
High (reference)						
Household income (N=628)						
Low	9.82	-0.13	19.78	-1.34	-3.60	0.92
Medium	6.60	-2.41	15.60	0.14	-2.07	2.34
High (reference)						

Table 4 presents the results on the associations of maternal education, paternal education, and relative household income with their children's TV viewing, computer use, DVD/video watching, and smartphone/tablet computer use. Compared to children whose mothers had a high level of education, those with a low or middle level of maternal education had a significantly increased risk of viewing TV over 72 minutes per day with the highest risk in the group with the lowest educated mothers (OR in low educated group: 2.59, 95% CI 1.58, 4.26; OR in middle educated group: 2.00, 95% CI 1.22, 3.27). Children whose fathers had a low level of education had an increased risk of viewing TV over 72 minutes day (OR: 1.96, 95% CI 1.21, 3.15) compared to their counterparts with a high paternal education. Compared to children who had a high level of household income, those with a low or middle level of household income had an elevated risk of viewing TV over 72 minutes per day with the highest risk in the group with the lowest income (OR in the low income group: 1.74, 95% CI: 1.05, 2.87; OR in the middle income group: 1.64, 95% CI 1.00, 2.69).

Children whose family had a middle level of household income had a higher risk of watching DVD/videos over 44 minutes per day (OR: 1.68, 95% CI: 1.05, 2.68) and a lower risk of using tablet computers/smartphones over 33 minutes per day (OR: 0.53, 95% CI: 0.33, 0.84) compared to their counterparts with a high household income.

Using the Benjamini-Hochberg procedure with the false discovery rate of 0.25, the association between low household income and children's screen time displayed in Table 3 became significant (data not shown). That is, children whose family had a low level of household income had more screen time compared to their counterparts with a high household income. All the previously mentioned results remained significant also using the Benjamini-Hochberg procedure.

Table 4. The associations between parental socioeconomic status and preschool children's daily average TV viewing, computer use, DVD/video watching and smartphone/tablet computer use measured by means of logistic regression analysis, and adjusted for municipality, season, and the children's gender and age in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland [1]

Socioeconomic status	TV viewing at home (over 72 minutes per day)[2]			Computer use at home (over 1 minute per day)[2]			DVD/video watching at home (over 44 minutes per day)[2]			Smartphone/tablet computer use (over 33 minutes per day)[2]		
Indicator	OR	Lower 95% CI	Higher 95% CI	OR	Lower 95% CI	Higher 95% CI	OR	Lower 95% CI	Higher 95% CI	OR	Lower 95% CI	Higher 95% CI
Maternal education (N =731)												
Low	2.59	1.58	4.26	1.14	0.77	1.68	1.12	0.68	1.84	0.98	0.61	1.59
Medium	2.00	1.22	3.27	0.67	0.45	1.02	1.27	0.80	2.00	1.38	0.92	2.06
High (reference)												
Paternal education (N= 679)												
Low	1.96	1.21	3.15	1.19	0.80	1.78	0.97	0.60	1.58	0.79	0.49	1.26
Medium	1.13	0.67	1.90	1.02	0.64	1.63	0.70	0.42	1.16	1.00	0.63	1.58
High (reference)												
Household income (N=630)												
Low	1.74	1.05	2.87	1.31	0.87	1.97	1.52	0.93	2.50	0.71	0.43	1.18
Medium	1.64	1.00	2.69	1.23	0.79	1.92	1.68	1.05	2.68	0.53	0.33	0.84
High (reference)												

[1] Values are odds ratios (95% confidence intervals)

[2] The highest 25% of parental reported children's screen-specific time in minutes per day (1) was compared to others

DISCUSSION

The main findings of this study show that children with low parental education had more overall screen time at home than their counterparts with highly educated parents, whereas those whose mothers had a higher as opposed to a lower level of education had more reading time. Screen-specific (TV viewing, DVD/video watching, computer use and tablet computer/smartphone use) analyses indicated that SES differences in overall screen time were mostly explained by TV viewing. Otherwise, parental SES was mainly unrelated to the children's objectively measured SED over the course of the week.

In our study, preschoolers with lower parental education had between 10 (paternal education) and 17 (maternal education) minutes more daily screen time at home than their counterparts with higher parental education. Especially, the children with lower SES backgrounds had an increased risk of viewing TV over 72 minutes per day, compared to children with higher SES backgrounds. Our results support therefore findings of other studies that conclude preschool children with low SES backgrounds tend to have higher risks to exceed the screen time recommendations [40-42]. However, a recent meta-analysis reports that the associations of SES and children's SB are dependent on the country so that SES is inversely associated especially with screen time and TV viewing time in high-income countries whereas SES is positively associated with 'other' screen time such as computers and videos in low-middle-income countries [43]. The clinical relevance of a 10 to 17 minutes educational difference in screen time at home requires further evaluation. The result, however, has public health importance when developing the strategies to diminishing socioeconomic gradient in preschool children's screen time.

Different types of screens have become part of everyday life in families with preschoolers, and controlling screen use may be difficult for parents. Higher as opposed to lower parental education is usually related to enhanced awareness, capabilities and skills in terms of adopting a healthy lifestyle [21]. Screen-time reduction may require additional resources (e.g. financial, time) that parents are not necessarily able to provide, which in turn could add to parental stress [44, 45]. Stress in combination with a lack of resources might make it challenging for parents with a low educational level to limit screen time among their children. Previous studies suggest that parents with lower SES backgrounds have less rules related to TV viewing, allow TV viewing more often, and view TV together with their child more frequently [22, 45, 46]. Other studies suggest that in general, parents might have strict screen

time rules for their children, but parents who are high screen users themselves more often fail to follow these rules and have joint screen time more frequently [47-51]. Parental rules and restrictions around children's screen time may therefore be important factor to focus in future interventions aiming to diminish SES gradient in children's screen time. Another potential factor may be the parental perceptions of suitable screen time for children [52], although possible SES differences in parental perceptions is less clear. The tighter norm for suitable children's screen time could mean tighter rules and restrictions around children's screen time. However, parental perceptions of the suitable amount of screen time as intervention strategy has not previously been used in interventions focusing on preschool children's screen time[53], although successful changes have been achieved in other health behavior interventions focusing on changing norms[54]. More study is anyhow needed to explore the potential factors acting as mediators in the associations between parental SES and children's screen time. Such information may help target and design more effective family-based interventions aiming to diminish socioeconomic gradient in children's screen time.

Parents seem to value optimal cognitive development during early childhood [55]. Previous studies have illustrated that parents of preschool-aged children consider screen-time activities to be good educational tools, whereas the detrimental effects of extensive screen time on cognitive development is not mentioned [56-59]. These studies have not taken possible SES differences into consideration. Parents with a higher level of education might realize the harmful health effects of increased screen time and place more value on their children's educational achievements, and therefore encourage them to spend more time with books instead of watching a screen. It may be that parents with a low educational background do not realize the detrimental effects of screen time on cognitive development, and place more value on the educational aspects. Still, it should be acknowledged that some aspects of screen time could be educational. Applications in touch-screen devices such as tablet computers and smart phones are being used to an increasing extent as learning tools in preschools, for example. However, there is little current research about the real educational benefits of using these tools [60]. The results of some studies suggest that the use of touch-screen devices inhibits social interaction and children's ability to self-regulate their behavior, although benefits related to early literacy skills, the stimulation of concentration and the fostering of independent learning are also acknowledged [60]. Nevertheless, screen time is usually sedentary in nature, and it is therefore important to limit its use.

The finding that reading and screen time had opposite relationships with parental SES attests to the necessity of measuring different types of SBs to fully understand the SES differences. SES differences in reading time in early childhood are seldom addressed in SB studies, for example, although its beneficial influences on cognitive development and school readiness are recognized [3, 61]. These contradictory SES associations with different types of SBs could also partly explain the few associations between overall objectively measured SED and indicators of SES found in this study. It would therefore be relevant to consider whether it might be more worthwhile focusing on the type of SB than overall SED in research on SES differences in children's SB. Similarly, the wide variation of screens currently available ensures variation in the way they are used. Tablet computers and mobile devices are used not only as behavioral-control tools to calm down or distract children in restaurants and cars, but also for educational purposes [44, 60, 62]. It may be worth considering the context in which the devices are used in future studies, as well as potential SES differences in the way they are used.

We did not find any SES differences in SED during preschool hours: to our knowledge, no other studies have addressed this issue. However, our finding is inconsistent with a previous study on school-aged children reporting that offspring with parents educated to university level or higher had less SED in schools than children with less highly educated parents [63]. The school setting with its compulsory lessons is different than the preschool setting, however. The Finnish preschool model is based on learning by playing, and compulsory pre-primary education in preparation for official schooling starts at the age of six [64]. We excluded pre-primary education classes during the recruitment phase of the DAGIS study. However, we did not measure children's specific SBs during preschool hours in more detail: we thought it would be too time-consuming to list specific SBs in diaries for each child in the preschool group. According to our preparatory work before we conducted this cross-sectional survey, the availability of screens in Finnish preschools is limited [65]. More research is therefore needed to shed light on the role of preschools in balancing SES differences in children's SB. Future studies could compare the associations between SES and SB among children who are attending preschool and those who are mainly cared for at home, for example.

There are some limitations that should be taken into account in interpreting the results of our study. The DAGIS study is cross-sectional, and therefore the causality between parental SES and children's SB cannot be fully established. The participation rate of families was low,

which may influence the generalizability of our findings. It might be that a selected sample of participants from preschools participated in this study. Similarly, children who did not produce valid accelerometer data for total time (6 %) and weekend SED (5 %) were more likely to have a mother with a lower level of education suggesting that included children are not representative of the overall study population. There are several accelerometer cut-points for SED among preschool children, and there is no consensus as to which are the most suitable. However, the results of a comparative study among 4-6 years old children support the choice of Evenson cut-points for measuring SED [28]. Moreover, the hip-worn accelerometer might not give the most accurate measurements because it does not effectively separate standing from sitting and reclining positions [32]. The information on children's screen time and reading was based on parental reports, and as with any other reported information, proxy reports may lead to bias in that parents might be unable to constantly monitor their children's behaviors [66, 67]. In addition, parents might have under- or over-reported in socially desirable manner the children's screen time and reading time. Nevertheless, the diary is generally considered to be more reliable than a few items in a questionnaire [68]. A major strength of this study is that it encompasses a large sample, including children from 66 different preschools in various municipalities. Another strength is that we measured the preschoolers' overall SED and specific SBs, and used several SES indicators. We also separated the different times of the week from the accelerometer data. We therefore contributed new information on how parental SES influences engagement in specific SBs and SED in different contexts. These novel data will be useful for future interventions focusing on diminishing preschoolers' SBs.

Conclusion

The most consistent finding from this study is that overall daily screen time at home is higher among children with a low parental-educational background even at preschool age. It would therefore be valuable to develop strategies aimed at diminishing screen time at home among these children. The findings exemplify the multidimensionality of the relationship between preschoolers' SBs and parental SES. Including multiple measurements of SBs and several indicators of parental SES, and taking into account the different contexts over the course of a week (e.g. preschool, weekend) would deepen understanding of the association between SES and preschoolers' SB.

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Supplementary material. The example of parent-reported diary measuring preschool children's screen time and reading time in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland

Day X

The date: __/___/2015

Did your child do any of the following activities today in sitting or being still?

	YES	NO	Times	Total time (h/min)
1. Television viewing	○	○		
2. DVD's or videos watching	○	○		
3. Tablet computer or smart phone use	○	○		
4. Computer use or playing computer games	○	○		
6. Reading or being read to or looking at books	○	○		

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 children's context-specific sedentary behaviors and parental socioeconomic status: 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	4	This study examines the associations of parental SES a) with preschool children's objectively measured ST over the course of a week, and b) with preschool children's parent-reported screen and reading time at home as indicators of their SBs.
Methods				
Study design	4	Present key elements of study design early in the paper	4	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5	As part of this project 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 of participants	4-5	Parents of 983 children (27% consent rate) gave their written consent for the study. Given the recruitment criterion of including only preschools with….
		(*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	5-6	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	*5-6*	Research assistant attached accelerometer to the child's waist in the preschool. The parents received written instructions about its use. During the seven days the children were wearing the accelerometers the parents filled in a diary ….
Bias	9	Describe any efforts to address potential sources of bias	5-8	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. Once the willingness of the preschools was ascertained information letters and consent forms were distributed to parents via the respective schools…
Study size	10	Explain how the study size was arrived at	6-8	Of the 864 participating children, 17 (2%) did not want to wear the accelerometer and 20 (2%) did not return the diary. In addition, two accelerometers were not installed properly and two were not returned. We therefore had data from 821 children (95% of the participants) to be used in forming the variables…

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Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5-7	The use of TV, computers, tablet computers, smartphones and DVD/Videos were combined into one variable, screen time. The weighted daily averages (5/7 on weekdays and 2/7 at weekends) of screen time and reading were calculated. No data on specific preschool-based SBs were collected
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7	The analyses were adjusted for municipality, the child's age and gender, and the season during which the accelerometer was used…
		(*b*) Describe any methods used to examine subgroups and interactions		
		(*c*) Explain how missing data were addressed	5, 7-8	Four variables with different time criteria were formed to indicate different times of the week:…
		(*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	8	The non-independence of observations due to cluster sampling (children in the preschool groups) was taken into account in the analyses, and the highest SES group was treated as a reference category…
		(*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	8	Of the 864 participating children, 17 (2%) did not want to wear the accelerometer and 20 (2%) did not return the diary. In addition, two accelerometers were not installed properly and two were not returned. We therefore had data from 821 children (95% of the participants) to be used in forming the variables…
		(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 Sample Characteristics in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted between years 2015 and 2016 in Finland (N=864)
		(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	Table 1 Sample Characteristics in the Increased Health and Wellbeing in Preschool (DAGIS) study conducted

				between years 2015 and 2016 in Finland (N=864)
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	9-12	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		

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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	12	In sum…
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	15	There are some limitations that should be taken into account in interpreting the results of our study. T
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-15	The finding that reading and screen time had opposite relationships with parental SES attests to the necessity of measuring different types of SBs to fully understand the SES differences.
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-15	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	16	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,