Journal of Sports Sciences

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rjsp20

Associations between educators' and children's physical activity and sedentary time in Norwegian preschools: A cross-sectional study

AKO Nilsen, H Espedal, KN Aadland & E Aadland

To cite this article: AKO Nilsen, H Espedal, KN Aadland & E Aadland (2023) Associations between educators' and children's physical activity and sedentary time in Norwegian preschools: A cross-sectional study, Journal of Sports Sciences, 41:3, 200-208, DOI: 10.1080/02640414.2023.2204638

To link to this article: https://doi.org/10.1080/02640414.2023.2204638

JOURNAL OF SPORTS SCIENCES
2023, VOL. 41, NO. 3, 200–208
https://doi.org/10.1080/02640414.2023.2204638

Routledge
Taylor & Francis Group

PHYSICAL ACTIVITY, HEALTH AND EXERCISE

Associations between educators' and children's physical activity and sedentary time in Norwegian preschools: A cross-sectional study

AKO Nilsen, H Espedal, KN Aadland and E Aadland

Western Norway University of Applied Sciences, Faculty of Education, Arts and Sports, Department of Sport, Food and Natural Sciences, Sogndal, Norway

ABSTRACT

Preschool educators may be important role models influencing children's physical activity (PA) behaviours. The main aim of this paper was to examine the relationship between educators' and children's PA and sedentary time (SED) by including 1230 children (mean age 4.8 yrs, 48% girls) and 422 educators (mean age 42.4 yrs, 90% women) from 68 preschools in Western Norway. PA and SED were measured over 10 preschool days using hip worn ActiGraph GT3×+ accelerometers. Associations between child and educator PA and SED during preschool hours, determined by multivariate pattern analyses, provided explained variances (R^2) = 2.8–5.2%. Levels of educator moderate PA were positively related to child PA (all intensities) and educator vigorous PA were positively related to child vigorous PA, while educator light PA was negatively associated with PA and positively associated with child SED. Educator SED were positively associated with child vigorous PA and negatively associated to child SED. Association patterns were similar for boys and girls, while educator moderate and vigorous PA were more strongly related to the younger vs. the older children's PA. The positive relationships between educators' moderate and vigorous PA and children's PA found herein suggest educators' PA behaviours should be addressed in future interventions.

ARTICLE HISTORY
Received 17 October 2022
Accepted 11 April 2023

KEYWORDS
Physical activity; accelerometer; teacher; preschool; "early childhood education and care"

Introduction

Sufficient levels of physical activity (PA), especially of moderate and vigorous intensities (MVPA), in childhood are essential for children's physical, motor, cognitive, and psychosocial development (Carson et al., 2016, 2017; Cliff et al., 2016; Veldman et al., 2021). The early years represent an important phase for the establishment of favourable PA behaviours as such behaviours track over time (Aadland et al., 2022; Downing et al., 2021; Jones et al., 2013). Despite the importance of the PA, many pre-schoolers aged 3–5 years fail to meet the international PA recommendations (Dias et al., 2019; Nilsen, Anderssen, Ylvisaaker, et al., 2019; O'Brien et al., 2018) of minimum 60-min MVPA per day (WHO, 2019). Identifying factors associated with PA in early childhood is therefore of great interest in developing effective PA promoting strategies.

Preschool environments and preschool educators have an essential role in, and a unique opportunity to, facilitate children's exploration, play, learning, and holistic development. The preschool environment is particularly pertinent in Norway, given that 97% of all 3–5-year-olds spend most of their waking time in this setting (Statistics Norway, 2021). A previous investigation showed that 77% of Norwegian children's total MVPA on weekdays were undertaken in preschool (Nilsen, Anderssen, Resaland, et al., 2019), which highlights the importance of this arena for children's opportunity to be physically active. However, there is a great variation in pre-schoolers' PA levels (Nilsen, Anderssen, Ylvisaaker, et al., 2019), and many children are physically inactive during preschool hours (Nilsen, Anderssen, Resaland, et al., 2019). Recent studies report that children spend between 43% and 50% of their time in preschool being sedentary (Ellis et al., 2017; Tonge et al., 2020; Nilsen, Anderssen, Resaland, et al., 2019).

Both individual characteristics (e.g., age, sex, genetics and previous PA levels) and environmental factors including both physical, cultural, and psychosocial environments, are known to influence children's PA in preschool (Tonge et al., 2016). In a qualitative investigation, Copeland et al. found the educators to have a specific role in pre-schoolers' opportunities to physically active play (Copeland et al., 2012). Given the influence educators have on children's behaviours in general (Sabol & Pianta, 2012), it is reasonable to believe that their PA behaviours might be associated with children's PA (Tonge et al., 2021), and thus, be important correlates of pre-schoolers' PA levels. However, only three previous studies have investigated associations between educators' and children's PA or sedentary time (SED) during preschool hours using objective measures (Chen et al., 2020; Fossdal et al., 2018; Tonge et al., 2021).

A Norwegian study by Fossdal et al. (n = 72 educators; n = 289 children aged 4–6 years) found a significant positive association between educators' average MVPA levels and children's MVPA levels in preschool, meaning that higher MVPA among the educators were associated with higher MVPA among

CONTACT AKO Nilsen adakn@hvl.no Faculty of Education, Arts and Sports, Department of Sport, Food and Natural Sciences, Western Norway University of Applied Sciences, Campus Sogndal, Sogndal 6851, Norway

Supplemental data for this article can be accessed online https://doi.org/10.1080/02640414.2023.2204638.

children, but did not report on associations for other PA intensities or SED (Fossdal et al., 2018). A Swedish study by Chen et al. (2020) ($n = 84$ educators; $n = 369$ children aged 3–5 years) found that preschool teachers' light PA (LPA) and the number of steps per day were positively associated with children's LPA and steps but found no associations for MVPA or SED (Chen et al., 2020). An Australian study by Tonge et al. ($n = 110$ educators; $n = 490$ children aged 2–5 years) found a positive association between educators' and children's SED, but no associations to other PA intensities (Tonge et al., 2021). Given these studies' conflicting findings, somewhat different methodology, the diversity in preschool settings, and relatively small study samples, more research is needed to determine associations between educators' and children's PA and SED in preschool. Moreover, to the best of our knowledge, no previous studies have investigated associations between specific characteristics among educators' and children's PA behaviours in preschool. For example, male educators are generally described as more motivated for physically active play and for spending time outdoors with the children as compared to female educators (Harris & Barnes, 2009; Sandberg & Pramling-Samuelsson, 2005), which correspond with results showing that male educators are more physically active than female educators (26 vs. 15 min of MVPA/day during preschool hours, respectively) (Lagestad & Kippe, 2021). However, the influence of differences in gender-related educator behaviour on child PA remains unclear.

Additional characteristics that might impact on educators' PA participation at work and, possibly, on children's PA behaviours in pre-school could be related to their health and qualifications. For example, given the inverse association between PA and weight status in adult populations (Bradbury et al., 2017), educators' body mass index (BMI) might be negatively associated with both their own PA levels as well as the children's PA, although this has not yet been investigated. Moreover, as promotion of PA requires expertise on child development and how PA is relevant for learning and health, the educational level and qualifications of educators might be highly relevant, although according to a systematic review by Tonge et al., evidence on associations between educator qualifications and children's PA remains inconclusive (Tonge et al., 2016).

Based on the above, the primary aim of this study was to examine the relationship between educators' and children's PA and SED in preschool. The secondary aim was to investigate the relationship between educators' characteristics and preschoolers' PA and SED.

Methods

The Sogn of Fjordane Preschool Physical Activity Study (PRESPAS) is a large population-based cross-sectional study conducted in the rural region of Sogn og Fjordane in Western Norway across one preschool year between September 2015 and June 2016 (Nilsen, Anderssen, Ylvisaaker, et al., 2019). All preschools with six or more children aged 3–6 years (i.e., born in 2010–2012) within 14 strategically selected municipalities were invited. In total, 68 preschools (92% of invited), and 1308 children (68% of invited) were included in the study. Additionally, we invited all preschool educators at the relevant departments (i.e., working with the included children) to participate in the study ($N = 580$), of which 453 accepted and participated in the study (80% of invited). For further recruitment details, see Nilsen et al. (Nilsen, Anderssen, Ylvisaaker, et al., 2019). It should be noted that the study sample and results may not be representative for preschools in general.

All educators and parents of included children provided written consent prior to testing. Children were provided with an explanation of the measurements according to their level of understanding and all testing took place in safe and familiar environments. The Norwegian Centre for Research Data (NSD) approved the study (reference number: 39061).

Procedures

Physical activity

PA was measured using ActiGraph GT3×+ accelerometers (ActiGraph, LLC, Pensacola, Florida, USA) (John & Freedson, 2012). The participants (educators and preschool children) were asked to wear the accelerometer in an elastic belt on their right hip for 14 consecutive days (10 preschool days). Participants were instructed to always wear the monitor, while awake (including naptime), except during water-based activities. Accelerometers were initialised to collect data at 30 Hz and were processed using 1- (children) and 10 s (adults) epoch data from the vertical axis using KineSoft version 3.3.80 (Loughborough, UK). Non-wear times were defined as periods of ≥20 min of zero counts for children (Esliger et al., 2005) and ≥ 60 min of zero counts with 2 min interruption allowance for adults (Troiano et al., 2008). A wear time of ≥270 min during hours 08:30–15:30 was used to define a valid preschool day (Nilsen, Anderssen, Resaland, et al., 2019). We required a minimum of 3 valid preschool days for inclusion in analyses. We used counts per minute (cpm) as a measure of overall PA. For children, we defined PA intensities as proposed by Evenson et al.: SED<100, LPA: 100–2295, MPA: 2296–4011, and VPA ≥ 4012 (Evenson et al., 2008). For adults, the cut points suggested by Troiano et al. were applied: SED <100, LPA: 100–2019, MPA: 2020–5998, and VPA: ≥5999 cpm (Troiano et al., 2008).

The daily averaged PA and SED data (06:00–23:59) were included for descriptive purposes using wear time criteria of 480 and 600 min per day for children and educators (Hansen et al., 2019; Nilsen, Anderssen, Ylvisaaker, et al., 2019), respectively, and a minimum of 3 valid weekdays and 1 valid weekend day for inclusion. To enable comparison with national representative data in adults (Hansen et al., 2019), educators' PA data were additionally analysed using 60-s epochs. Adherence to PA recommendations for children were determined by accumulating an average of ≥60 min of MVPA per day (WHO, 2019). Adherence to PA recommendations in the adult sample were determined by accumulating a daily average ≥ 21.4 min MVPA/day and/or≥10.7 min VPA/day, corresponding to a weekly amount of at least 150 and/or 75 min of MVPA and VPA, respectively (WHO, 2020). For analyses of associations between educators' and children's' PA and SED, educator PA/SED was aggregated at the preschool level by calculating the

means of the respective outcomes of all educators in each preschool.

Anthropometry, outdoor time, and demographics

Children's and educators' body weight and height were measured at preschool by trained personnel. Participants wore light clothing and no shoes. Body weight was measured to be nearest 0.1 kg using an electronic scale (Seca 899, SECA GmbH, Hamburg, Germany). Height was measured to the nearest 0.1 cm using a portable stadiometer (Seca 217, SECA GmbH, Hamburg, Germany). We calculated BMI as body weight (kg)/height (m^2) and children (Cole et al., 2000) and educators (Flegal et al., 2012) were classified as normal weight (including underweight), overweight, or obese according to established WHO thresholds.

We used the highest education level of a child's mother or father as a proxy for socioeconomic status (SES) derived from parent-report (upper secondary school or less, university < 4 years, or university ≥ 4 years). Preschool educators' age, sex, position in preschool, general educational level (upper secondary school or less, university < 4 years, or university ≥ 4 years), and PA-related education (yes/no) were assessed by questionnaire, and participants' age at the time of PA measurement were calculated. Educator work positions in preschool were categorised as either director, preschool teacher, assistant, or "other positions" (e.g., health care workers, skilled workers (with different educational backgrounds), children and youth workers, and special educators). Children's outdoor time during the preschool day were logged by educators throughout the accelerometer monitoring period and were reported for descriptive purposes.

Statistical analysis

Descriptive data are presented as frequencies, medians, means and standard deviations (SD), and 95% confidence intervals (CI) as appropriate. Attrition analyses between included and excluded participants were performed using linear mixed models for continuous variables and general estimation equations for categorical variables taking clustering within preschools into account.

We applied a linear mixed model including random intercepts for preschools to explore associations between educator PA and educator characteristics (individual data) and between child PA (individual data) and educator characteristics (aggregated data). We included child accelerometer wear time, sex, age, and BMI as covariates, and the same for educators when analysing their individual data.

We analysed associations between PA and SED of children (individual data, each variable used as outcomes in separate models) and educators (aggregated data, all variables included as explanatory variables in joint regression models) using multivariate pattern analysis (Partial least-squares regression analysis, PLS) (Aadland et al., 2018, 2019; Kvalheim & Karstang, 1989; Wold et al., 1984). The PLS regression can handle completely collinear variables through decomposing the explanatory variables into orthogonal linear combinations (PLS components), while simultaneously maximising the covariance with the outcome variable (Wold et al., 1984). The models were cross validated using Monte Carlo resampling (Kvalheim et al., 2018) with 1000 repetitions by repeatedly and randomly keeping 50% of the subjects as an external validation set. For each model, we used target projection (Kvalheim & Karstang, 1989; Rajalahti & Kvalheim, 2011) and reported multivariate correlation coefficients with 99% CIs to show the importance of each explanatory PA intensity variable (educator PA and SED) in relation to the outcome (child PA and SED) (Aadland et al., 2019; Rajalahti, Arneberg, Berven, et al., 2009; Rajalahti, Arneberg, Kroksveen, et al., 2009). For adjustment of child PA/SED estimates, we obtained residuals from linear regression models including the PA/SED variables as outcomes (separate models) and accelerometer wear time, sex, age, and BMI as explanatory variables prior to performing the PLS analyses. We analysed the data for the total sample of children in addition to secondary analyses for boys and girls, and for the 50% youngest and 50% oldest children (median split for age), in separate models.

The PLS analyses were performed using Sirius version 11.5 (Pattern Recognition Systems AS, Bergen, Norway), all other analyses were performed using IBM SPSS v. 28 (IBM SPSS Statistics for Windows, Armonk, NY; IBM Corp., USA). Associations were interpreted as statistically significant for p values ≤ 0.05 for results derived from linear mixed models and p ≤ 0.01 for results from multivariate pattern analyses (i.e., we used a conservative approach as we could not take clustering among preschools into account in these analyses).

Results

A total of 1230 children (94% of included; 48% girls, average age 4.7 (0.9) years) and 422 educators (93% of included; 90% female, average age 42.4 (11.4) years) provided valid PA data and were included in the analyses (i.e., those who did not, were excluded). Most children were born in Norway (95%) and had a normal weight status (82%) (Table 1). Attrition analyses showed that PA and SED (p = 0.178–0.626), BMI (p = 0.959), sex (p = 0.069), age (p = 0.238), or general educational level (p = 0.063) did not differ between included and excluded educators. However, included educators reported having PA-specific education more frequently than excluded educators (p = 0.009). There was no difference between included and excluded children with respect to MPA, VPA, BMI, sex, or parental education level, but included children were older and had more SED and less LPA than excluded children (p = 0.001–0.034).

The children and educators had a median of 9 and 10 preschool days of valid PA data, respectively (Table 2). Children and educators spent 66% and 62% of the preschool day being sedentary, 22% and 33% of the day in LPA, 6% and 5% of the day in MPA, and 6% and 0.2% in VPA, respectively. In total, 72% of the children and 68–92% of the educators (depending on the epoch setting applied) achieved the guideline amounts of PA per day (Table 2).

Figure 1 illustrates the multivariate correlations between aggregated *educator* PA and SED (explanatory variables) and individual *child* PA and SED (outcomes) for the whole sample. We observed that educator SEDs were positively related to child VPA and negatively related to child SED, whereas

Table 1. Child and educator characteristics and demographics.

	N	Children	*N*	Educators
Sex (% female)	*1308*	48.3	*453*	90.1
Age (years (SD))	*1308*	4.7 (0.9)	*453*	42 (11)
Body mass index (kg/m^2)	*1249*	16.2 (1.4)	*410*	26.2 (4.4)
Weight status* (%)	*1249*		*410*	
Normal	*1023*	82	*186*	45
Overweight	*196*	16	*156*	38
Obese	*30*	2	*68*	17
Parental/educator education level ** (%)	*1087*		*422*	
Upper secondary school or less	*248*	23	*176*	42
University < 4 years	*282*	26	*150*	35
University ≥ 4 years	*557*	51	*96*	23
Outdoor time (hours/day (SD))	*1238*	2.8 (0.8)	-	-
Physical activity related education (%"yes")	-	-	*414*	20
Educator position (%)	-	-	*424*	
Director	-	-	*60*	14
Preschool teacher	-	-	*154*	36
Assistant	-	-	*175*	41
*Other****	-	-	*35*	9

*Note: Results are presented as means and standard deviations (SD) and percentages. *Weight status: according to Cole et al. 2000 for children and according to Flegal et al., 2012 for adults; **For parental education level, the highest level of mother or father is used; ***Other positions, e.g., health care workers, skilled workers (with different educational backgrounds), children-and youth workers, and special educators.*

Table 2. Physical activity estimates for children and educators (all positions).

	Children	Educators	
	1 sec epoch	*10 sec epochs*	*60 sec epochs*
Total day (all days)	***n*=1153**	***n*= 385**	
Wear time (min/day)	700 (50)	842 (51)	877 (49)
Total PA (cpm)	721 (195)	393 (120)	369 (119)
SED (min/day)	485 (42)	555 (53)	485 (63)
LPA (min/day)	142 (20)	239 (45)	358 (57)
MPA (min/day)	36 (7)	44 (19)	31 (18)
VPA (min/day)	35 (11)	2.8 (5.7)	2.3 (5.5)
MVPA (min/day)	71 (17)	47 (22)	33 (20)
Achievement of WHO guidelines* (%)	72	92	68
Preschool hours (weekdays)	***n*=1230**	***n*=422**	
Mean wear time preschool hours (min/preschool day)	408 (13)	404 (16)	409 (13)
Total PA (cpm)	804 (249)	407 (133)	383 (128)
SED (min/preschool day)	269 (22)	248 (33)	195 (42)
LPA (min/preschool day)	92 (14)	135 (32)	202 (40)
MPA (min/preschool day)	24 (5)	21 (10)	12 (9)
VPA (min/preschool day)	23 (8)	0.7 (1.8)	0.4 (1.7)
MVPA (min/preschool day)	47 (13)	22 (11)	12 (9)

*Note: Results are reported as means and standard deviations, except for achievement of WHO guidelines (%). Total day: mean between 06:00–22:00 hours including weekdays and weekends; Preschool hours: Minutes per day between hours of 08:30 and 15:30 on weekdays. *WHO Guidelines for children: ≥ 60 min moderate-to-vigorous intensity physical activity per day; adults: ≥ 150 minutes of moderate-intensity physical activity and/or ≥ 75 minutes of vigorous intensity physical activity throughout the week (WHO, 2020). Note: TPA – total physical activity; SED – sedentary time; LPA – light-intensity physical activity; MPA – moderate-intensity physical activity; VPA – vigorous-intensity physical activity; MVPA – moderate- to vigorous-intensity physical activity.*

associations for other PA intensities of children were non-significant. Educator LPA was negatively related to child PA (all intensities), and positively related to child SED, while educator MPA was positively related to child PA (all intensities) and negatively related to child SED. Educator VPA was positively related to child VPA but not related to other PA intensities or SED. Overall, the correlations were weak ($r < 0.22$), and the explained variances (R^2) ranged from 2.8% (for child MPA) to 5.2% (for child SED) between models.

Supplementary Figures S1 and S2 show child sex- and age-specific multivariate correlations between educator and child PA and SED. Overall, the association patterns were similar for boys and girls, although associations were marginally stronger in boys than in girls (R^2 = 5.3–7.6% vs. 3.0–4.6% in boys and girls, respectively) (Figure S1). For younger and older children (median split by age), the association patterns differed for educator SED and LPA; While educator SED and LPA were not related to the younger children's PA or SED, educator SED was positively related to VPA, MPA, and LPA, and negatively related to SED in the older children, and educator LPA was negatively related to VPA, MPA, and LPA, and positively related to SED in the older children. For educator MPA and VPA, association patterns were similar between for both age groups. The educator PA and SED explained relatively more of the older vs. younger children's LPA (R^2 = 3.2 vs. 6.1%) and SED (R^2 = 4.9 vs. 6.2%) (Figure S2).

Supplementary Table S1 provides estimates for associations between *educator* PA and SED and *educator* characteristics (individual data). Male educators had higher MPA levels than their female colleagues. SED decreased and PA increased with older age, and educators with higher BMIs had lower VPA levels. Moreover, SED increased, and PA decreased by higher

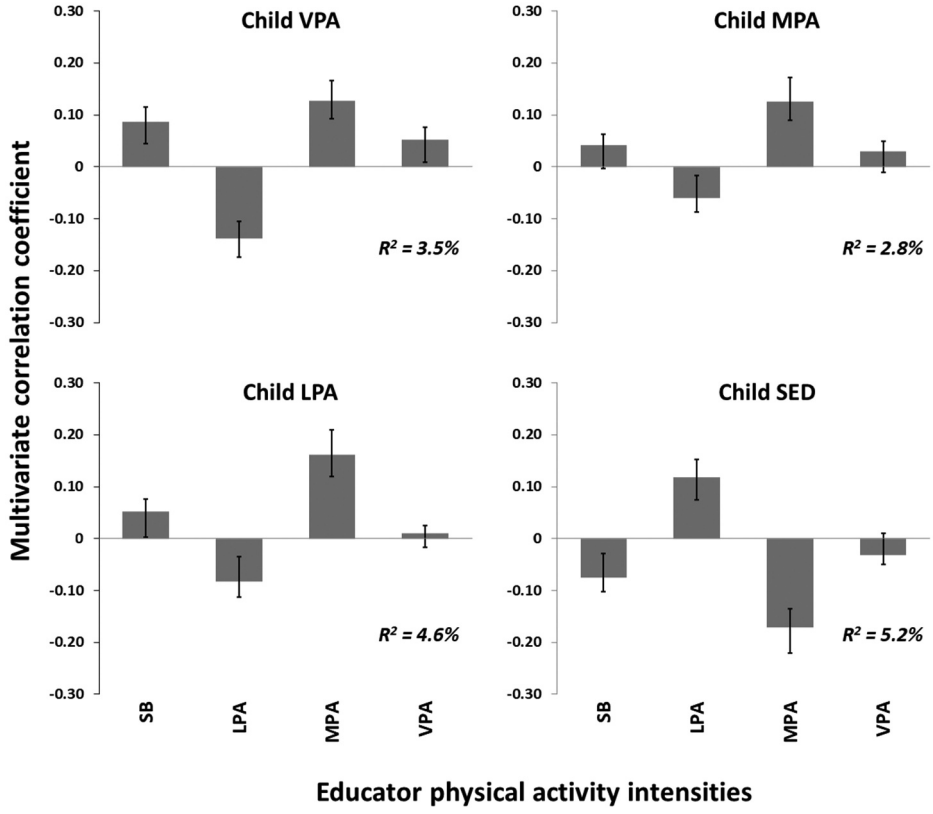

Figure 1. The association patterns between aggregated educator physical activity intensities and sedentary time (explanatory variables) and individual child physical activity and sedentary time (outcomes) for the whole study sample. Results are reported as multivariate correlation coefficients from joint models including all four physical activity intensities for educators and each of the outcomes (both derived from vertical axis). The correlation coefficients can be interpreted equivalent to bivariate correlations, though they are derived from the full multivariate model.

Table 3. Associations (linear-mixed model) between children's sedentary time and physical activity during preschool hours (dependent variables) and educator characteristics (independent variables).

	Child sedentary time and physical activity (min/day)							
	SED		LPA		MPA		VPA	
Educator characteristics	*β (CI)*	*p*	*β (CI)*	*p*	*β (CI)*	*p*	*β (CI)*	*p*
Sex	**−0.2**	**0.050**	0.11	0.051	0.03	0.113	0.03	0.297
Per percent increase in male educators	**(−0.3 to −0.004)**		(−6.7 to 0.2)		(−0.01 to 0.1)		(−0.03 to 0.1)	
Age (years)	0.3	0.124	−0.2	0.068	−0.04	0.331	0.07	0.385
	(−0.1 to 0.8)		(−0.5 to 0.02)		(−0.1 to 0.04)		(−0.2 to 0.1)	
Body mass index (kg/m^2)	**1.3**	**0.019**	**−0.9**	**0.010**	**−0.3**	**0.006**	−0.2	0.306
	(0.2 to 2.4)		**(−1.6 to −0.2)**		**(−0.5 to −0.1)**		(−0.6 to 0.2)	
Educational level	0.1	0.294	−0.1	0.170	−0.01	0.532	0.01	0.641
Per percent increase in staff that have ≥ 1 year of university education	(−0.1 to 0.2)		(−0.1 to 0.02)		(−0.03 to 0.02)		(−0.05 to 0.03)	
PA specific education	0.004	0.957	−0.02	0.616	−0.005	0.734	0.02	0.344
Per percent increase in staff that have PA related education	(−0.1 to 0.1)		(−0.1 to 0.1)		(−0.03 to 0.02)		(−0.03 to 0.07)	
Preschool teachers	−0.04	0.557	0.03	0.462	0.0001	0.997	0.02	0.634
Per percent increase in staff with preschool teacher education	(−0.2 to 0.09)		(−0.05 to 0.1)		(−0.03 to 0.03)		(−0.04 to 0.06)	
Assistants	0.02	0.737	−0.04	0.337	0.01	0.676	0.01	0.622
Per percent increase in staff classified as assistants	(−0.1 to 0.1)		(−0.1 to 0.04)		(−0.02 to 0.03)		(−0.03 to 0.05)	

Note: Educator characteristics are analysed as means per preschool and child physical activity (light; LPA, moderate-to vigorous: MVPA) and sedentary time (SED) as individual data. Educator age and body mass index (BMI) were used as continuous variables, other variables as means of dichotomous variables reported in percentage range with values from 0 to 1; Sex: male =1; female = 0; Educational level: no university education = 0, university ≥ 1 year = 1; PA specific education analysed as "no" = 0 or "yes" = 1; Preschool teacher analysed as either other positions = 0 or preschool teacher = 1; Assistant analysed as either other positions = 0 or assistant = 1. Analyses are adjusted for child sex, age, BMI, accelerometer wear time and preschool cluster (random effect).

educational level. Employees with leader positions (directors) and pedagogical competence had lower PA levels at work, and educators who reported to have PA-specific education had higher VPA levels compared to those who did not (Table S1).

Associations between *educator* characteristics and *child* PA and SED (Table 3) showed that children from preschools with a higher proportion of male educators had less SED than preschools with more female educators. Moreover, children attending preschools where educators had higher mean BMI levels engaged in less LPA and MPA, and more SED, than those attending preschools with educators with lower BMI. There were no significant associations between child SED or PA and the proportion of preschool teachers or assistants, or educators' general- or PA specific education (Table 3).

Discussion

Previous research has addressed levels of PA and correlates of PA in pre-schoolers, but the PA behaviours and characteristics of educators and the associations between children' and educators' PA, are rarely investigated. Our main finding from this study is that educator and child PA during preschool hours are related. Although causal interference cannot be drawn for cross-sectional designs, it is reasonable to suggest that targeting and increasing educators' PA of at least moderate intensity may favourably influence on children's PA levels.

The multivariate correlations presented in this study showed that more MPA and VPA among educators were related to higher levels of PA in children. This finding is consistent with the results of the other Norwegian study, by Fossdal et al., but in contrast to those of Chen et al. and Tonge et al., who reported negative and non-associations, respectively (Chen et al., 2020; Fossdal et al., 2018; Tonge et al., 2021). As outdoor time is strongly associated with more MVPA in children (Tandon et al., 2018; Truelove et al., 2018; Ylvisåker et al., 2021), and because the children in our sample spent almost 3 hours a day outdoors, the conflicting findings among studies could be an expression of cultural differences in preschool practices.

Surprisingly, we found that increased adult LPA was associated with lower PA and higher SED in the children, which contrasts the findings of Chen et al., who reported positive associations between educator and child LPA (Chen et al., 2020) and Tonge et al., who reported on positive associations between educator and child SED (Tonge et al., 2021). We may only speculate that educators who facilitate much sedentary table activities or indoor activities for the children have higher levels of LPA due to organising of these activities. Moreover, despite both the indoor and outdoor preschool environments being important for children's exploration, learning, and development, educator's perceived role tends to differ between these environments (Tonge et al., 2021). For example, studies have shown that educators subconsciously transition from an engaged "educator" to a more passive "supervisor" as they move outdoors (Leggett & Newman, 2017). This change in perceived educator-role might result in educators standing relatively still close to where children play, scanning the outdoor space to avoid and eliminate risky situations, possibly restricting the children's engagement in risky and vigorous play. A study by Johannessen et al., on associations between child PA and preschool quality, showed that preschools who scored high on "supervision of gross motor activities" and "general supervision of children" had lower MVPA levels among the children (Johannessen et al., 2020), which could explain how increased adult LPA (i.e., increased supervision) can be negatively associated with PA and positively associated with SED in the children. At the same time, we hypothesise that educators who engage in MPA to a large extent do so *with* the children, contrary to the time they spend in LPA and SED, as such behaviours may also be related to administrative and routine tasks. As such, the associations between educator MPA (and VPA) and child PA might be the most relevant ones. Unfortunately, we do not have any data on educators' specific behaviours to provide an in-depth account of these relationships.

The discrepancies between studies regarding associations between educators' and children's PA in preschool may be explained by application of different approaches to classify PA intensity (both in children and educators), accelerometer epoch settings, differences in sample sizes, the analytical approach applied, and variation in sample characteristics and educational practices regarding, for example, amounts of outdoor time and culture for educator involvement in PA. Importantly, the other comparable studies did only investigate the same PA intensities and SED in educators and children against each other and did not investigate how the spectrum of intensities in educators were associated with children's PA and SED, like in the present study.

The present study is the first to analyse sex- and age-specific associations between educator's and children's PA. In the subgroup analyses, we found only marginal differences in association patterns between boys and girls, however, the patterns differed somewhat across the two age groups. Overall, educator SED and LPA seem unrelated and MPA and VPA more strongly related to the younger vs. the older children's PA. This might imply that the younger children possibly depend more on facilitation for higher intensities than the older children (who play more vigorously independently, e.g., when outdoors), but that the older pre-schoolers might be more affected (or restricted) by educator behaviours in terms of LPA and SED. If so, the importance of role model behaviour in influencing child behaviour may be changing somewhat by the children's age and developmental stage, but experimental research is needed to confirm this.

The secondary aim of this paper was to investigate associations between educator characteristics children's PA and SED. We found that male educators were more physically active at work than female educators (+5.7 min/day in MVPA), which corresponds well with findings from a previously Norwegian investigation (Lagestad & Kippe, 2021) and in general with research in adult populations (Sallis et al., 2016). This finding indicates that male educators might have other priorities regarding PA participation when at work (Harris & Barnes, 2009; Sandberg & Pramling-Samuelsson, 2005). Importantly, we found that children who attended preschools with a higher share of male educators tended to be less sedentary, although no significant associations were present for intensity-specific PA. Because of the small proportion of men, it is a goal

both nationally and internationally to recruit more men to preschool positions to ensure sufficient male role models (Clarke & Miho, 2019).

Despite weak associations, we found that educators with higher BMI had lower VPA levels, a tendency that children attending preschools with high average BMI among educators had slightly lower LPA and MPA levels, and more SED. The association between PA and weight status among adults is consistent with the prevailing evidence (Bradbury et al., 2017), but it is interesting to observe that it might further impact on PA facilitation for the children. This highlights the importance of healthy weight among educators, not only for their own health but for children to have physically active and engaged role models providing opportunities for physical exploration.

The fact that SED increased, and PA decreased, by higher educational level and differed by work position among educators is reasonable because educated preschool teachers and directors have more administrative tasks and meetings than, e.g., assistants. In Norway, 41% of the core staff are qualified preschool teachers or hold equivalent qualifications (The Norwegian Directorate for Education and Training, 2022a), which correspond well with the distribution in the present study sample. The age-trend showing higher PA levels by increased age among educators can probably be explained by the higher proportion of assistants among older employees than among younger employees. All the preschool teachers (36% of educator sample) have had PA-specific curriculum in their basic education, but even though those who reported to have such qualifications tended to be more vigorously active at work, their expertise in PA was not associated with children's PA levels. As stated in the systematic review by Tonge et al., evidence on associations between educator qualifications and children's PA remains inconclusive (Tonge et al., 2016); thus, this issue needs to be further addressed.

Strengths and limitations

This study is one of the few to investigate the relationship between educator's and children's PA and SED in preschool. The objective measurement of PA and including 10 preschool days, as compared to a commonly applied 5–7-day monitoring protocol, is a strength of this study, providing solid PA estimates for both children and educators. Moreover, we included large samples of children and educators that provided improved power compared to previous studies (Chen et al., 2020; Fossdal et al., 2018; Tonge et al., 2021). The use of multivariate pattern analysis is another strength, allowing for combining all highly correlated PA variables in a joint regression model (Aadland et al., 2018, 2019; Kvalheim & Karstang, 1989; Wold et al., 1984). However, some limitations should be acknowledged. The multivariate correlations found herein were rather weak, and the explained variance small across models; thus, the possibility of chance findings is present when running multiple analyses. Also, the nature of the relationships between educators' and children's PA and SED may have been diluted given that the educator data were aggregated within each preschool, i.e., we do not know which educators spent time with which children at what time. Moreover, although possible variation in PA by season should not affect the *associations between* children and educator PA *across* seasons (data collected throughout one preschool year), this aspect should be kept in mind when comparing study results. Future observational studies should aim to obtain more detailed information on interactions between educators and children in such analyses. Moreover, the study was conducted in a rural area in Western Norway, therefore the study sample and results may not be representative for Norwegian preschools in general. Nevertheless, it should be noted that the distribution of sex, age, and qualifications of the educators involved are representative to national levels (The Norwegian Directorate for Education and Training, 2022a, 2022b). Finally, as the study has a cross-sectional design, causality could not be inferred. However, we find it reasonable to believe that educators influence children's PA behaviours to a larger extent than children influence educators' PA behaviours.

Perspectives

Although most children and educators in our sample achieved the guideline amounts of PA per day, they also spent most of their day being sedentary. Moreover, children and educators spend less than 12 and 6% of the preschool day in MVPA, respectively, meaning there's a great potential to increase MVPA in both children and educators. Preschool-based interventions targeting children's PA and SED have been reported, although so far, most lack effectiveness (Finch et al., 2016). Copeland et al. suggests that to increase children's PA in preschool settings one must target and support the key decision-makers (i.e., the educators) in how to engage in physically active play with the children (Copeland et al., 2012). However, little focus has been laid on the efficacy of modifying educators' PA behaviours.

The non-existing relationship between the degree of PA-specific education and levels of PA among the children found herein might indicate that theory is not put into practice, that the content of PA specific education focus more on learning of motor skills rather than intensity, or that the assistants engage in relatively more MVPA (for example, through more outdoor time) because of less administrative tasks and more time with the children throughout the day. It should be mentioned that a part of the educator's profession is that they should offer children learning environments that attract children to be physically active, which is not always the question of the educators own PA behaviour. Nevertheless, this is a paradox that needs further clarification. As the present study showed tendencies to lower PA levels among educated preschool teachers when compared to assistants, future intervention studies should consider professional development focusing on the role and behaviours of educators in promotion of PA at preschool.

Conclusion

The preschool environment is significant in promoting PA in young children. Given the important influence of educator role modelling for children's behaviours, a critical social factor influencing children's MVPA may be the PA levels of educators. Although causal interference cannot be drawn for cross-sectional studies, the positive and favourable relationship

between educators' MPA and VPA and children's PA found herein, makes an important contribution to the field's understanding of the correlates of children's PA in preschool, and provides evidence for focusing on educators' PA behaviours and role in facilitation of PA in future interventions.

Authors' contributions

EAA designed and obtained funding for the study. EAA and AKON developed the research questions. AKON collected the data. AKON analysed the data and drafted the manuscript. All authors contributed to the drafting and the final version of the paper.

Acknowledgments

This research has been conducted with the support of Sogn og Fjordane University College and the Sogn og Fjordane County Municipality. We are grateful to all children and preschool educators who participated in this study.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

The work was supported by the Sogn og Fjordane University College.

ORCID

AKO Nilsen http://orcid.org/0000-0003-0865-7739
E Aadland http://orcid.org/0000-0001-9654-2653

References

Aadland, E., Andersen, L. B., Resaland, G. K., & Kvalheim, O. M. (2019). Interpretation of multivariate association patterns between multicollinear physical activity accelerometry data and cardiometabolic health in children—A tutorial. *Metabolites*, *9*(7), 129. https://doi.org/10.3390/metabo9070129

Aadland, E., Kvalheim, O. M., Anderssen, S. A., Resaland, G. K., & Andersen, L. B. (2018). The multivariate physical activity signature associated with metabolic health in children. *The International Journal of Behavioral Nutrition and Physical Activity*, *15*(1), 77. https://doi.org/10.1186/s12966-018-0707-z

Aadland, E., Okely, A. D., & Nilsen, A. K. O. (2022). Trajectories of physical activity and sedentary time in Norwegian children aged 3–9 years: A 5-year longitudinal study. *The International Journal of Behavioral Nutrition and Physical Activity*, *19*(1), 67. https://doi.org/10.1186/s12966-022-01286-0

Bradbury, K. E., Guo W, Cairns BJ, Armstrong ME, Key TJ. (2017). Association between physical activity and body fat percentage, with adjustment for BMI: A large cross-sectional analysis of UK Biobank. *BMJ Open*, *7*(3), e011843. https://doi.org/10.1136/bmjopen-2016-011843

Carson, V., Hunter S, Kuzik N, Wiebe SA, Spence JC, Friedman A, Tremblay MS, Slater L, Hinkley T (2016). Systematic review of physical activity and cognitive development in early childhood. *Journal of Science and Medicine in Sport*, *19*(7), 573. https://doi.org/10.1016/j.jsams.2015.07.011

Carson, V., Lee, E. -Y., Hewitt, L., Jennings, C., Hunter, S., Kuzik, N., Stearns, J. A., Unrau, S. P., Poitras, V. J., Gray, C., Adamo, K. B., Janssen, I., Okely, A. D., Spence, J. C., Timmons, B. W., Sampson, M., & Tremblay, M. S. (2017). Systematic review of the relationships between physical activity and health indicators in the early years (0-4 years). *BMC Public Health*, *17*(Suppl 5), 854. https://doi.org/10.1186/s12889-017-4860-0

Chen, C., Ahlqvist, V. H., Henriksson, P., Magnusson, C., & Berglind, D. (2020). Preschool environment and preschool teacher's physical activity and their association with children's activity levels at preschool. *PloS One*, *15*(10), e0239838. https://doi.org/10.1371/journal.pone.0239838

Clarke, C. & Miho, A., *Good practice for good jobs in early childhood education and care*. 2019. OECD, [cited. 2022 04 10]; Available from: https://read.oecd-ilibrary.org/social-issues-migration-health/good-practice-for-good-jobs-in-early-childhood-education-and-care_64562be6-en#page1

Cliff, D. P., Hesketh, K. D., Vella, S. A., Hinkley, T., Tsiros, M. D., Ridgers, N. D., Carver, A., Veitch, J., Parrish, A. -M., Hardy, L. L., Plotnikoff, R. C., Okely, A. D., Salmon, J., & Lubans, D. R. (2016). Objectively measured sedentary behaviour and health and development in children and adolescents: Systematic review and meta-analysis. *Obesity Reviews*, *17*(4), 330. https://doi.org/10.1111/obr.12371

Cole, T. J., Bellizzi MC, Flegal KM, Dietz WH. (2000). Establishing a standard definition for child overweight and obesity worldwide: International survey. *BMJ*, *320*(7244), 1240. https://doi.org/10.1136/bmj.320.7244.1240

Copeland, K. A., Kendeigh, C. A., Saelens, B. E., Kalkwarf, H. J., & Sherman, S. N. (2012). *Physical activity in child-care centers: Do teachers hold the key to the playground?* Health educ res. *Health Education Research*, *27*(1), 81. https://doi.org/10.1093/her/cyr038

Dias, K. I., White, J., Jago, R., Cardon, G., Davey, R., Janz, K., Pate, R., Puder, J., Reilly, J., & Kipping, R. (2019). International comparison of the levels and potential correlates of objectively measured sedentary time and physical activity among three-to-four-year-old children. *International Journal of Environmental Research and Public Health*, *16*(11), 1929. https://doi.org/10.3390/ijerph16111929

Downing, K. L., Hinkley, T., Timperio, A., Salmon, J., Carver, A., Cliff, D. P., Okely, A. D., & Hesketh, K. D. (2021). Volume and accumulation patterns of physical activity and sedentary time: Longitudinal changes and tracking from early to late childhood. *The International Journal of Behavioral Nutrition and Physical Activity*, *18*(1), 39. https://doi.org/10.1186/s12966-021-01105-y

Ellis, Y. G., Cliff, D. P., Janssen, X., Jones, R. A., Reilly, J. J., & Okely, A. D. (2017). *Sedentary time, physical activity and compliance with IOM recommendations in young children at childcare*. Preventive medicine reports. *Preventive Medicine Reports*, *7*, 221. https://doi.org/10.1016/j.pmedr.2016.12.009

Esliger, D. W., Copeland, J. L., Barnes, J. D., & Tremblay, M. S. (2005). Standardizing and optimizing the use of accelerometer data for free-living physical activity monitoring. *Journal of Physical Activity & Health*, *2*(3), 366. https://doi.org/10.1123/jpah.2.3.366

Evenson, K. R., Catellier, D. J., Gill, K., Ondrak, K. S., & McMurray, R. G. (2008). Calibration of two objective measures of physical activity for children. *Journal of Sports Sciences*, *26*(14), 1557. https://doi.org/10.1080/02640410802334196

Finch, M., Jones, J., Yoong, S., Wiggers, J., & Wolfenden, L. (2016). Effectiveness of centre-based childcare interventions in increasing child physical activity: A systematic review and meta-analysis for policymakers and practitioners. *Obesity Reviews*, *17*(5), 412. https://doi.org/10.1111/obr.12392

Flegal, K. M., Carroll, M. D., Kit, B. K., & Ogden, C. L. (2012). Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. *JAMA*, *307*(5), 491. https://doi.org/10.1001/jama.2012.39

Fossdal, T. S., Kippe, K., Handegård, B. H., & Lagestad, P. (2018). "Oh oobe doo, I wanna be like you" associations between physical activity of preschool staff and preschool children. *PloS One*, *13*(11), e0208001. https://doi.org/10.1371/journal.pone.0208001

Hansen, B. H., Kolle, E., Steene-Johannessen, J., Dalene, K. E., Ekelund, U., & Anderssen, S. A. (2019). Monitoring population levels of physical activity and sedentary time in Norway across the lifespan. *Scandinavian Journal of Medicine & Science in Sports*, *29*(1), 105. https://doi.org/10.1111/sms.13314

Harris, K., & Barnes, S. (2009). Male teacher, female teacher: Exploring children's perspectives of teachers' roles in kindergartens. *Early Child Development and Care*, *179*(2), 167. https://doi.org/10.1080/03004430802667005

Johannessen, K., Bjørnestad, E., Nilsen, A. K. O., Ylvisåker, E., Nornes-Nymark, M., Engeseter, M., Pedersen, L., & Aadland, E. (2020). Associations for preschool environmental quality with outdoor time and moderate-to-vigorous physical activity in Norwegian preschools. *Journal for Research in Arts and Sports Education*, *4*(2), 7. https://doi.org/10.23865/jased.v4.2485

John, D., & Freedson, P. (2012). ActiGraph and actical physical activity monitors: A peek under the hood. *Medicine & Science in Sports & Exercise*, *44*(1), S86. https://doi.org/10.1249/MSS.0b013e3182399f5e

Jones, R. A., Hinkley, T., Okely, A. D., & Salmon, J. (2013). Tracking physical activity and sedentary behavior in childhood a systematic review. *American Journal of Preventive Medicine*, *44*(6), 651. https://doi.org/10.1016/j.amepre.2013.03.001

Kvalheim, O. M., Arneberg, R., Grung, B., & Rajalahti, T. (2018). Determination of optimum number of components in partial least squares regression from distributions of the root-mean-squared error obtained by Monte Carlo resampling. *Journal of Chemometrics*, *32*(4), 12. https://doi.org/10.1002/cem.2993

Kvalheim, O. M., & Karstang, T. V. (1989). Interpretation of latent-variable regression models. *Chemometrics and Intelligent Laboratory Systems*, *7* (1–2), 39. https://doi.org/10.1016/0169-7439(89)80110-8

Lagestad, P., & Kippe, K. (2021). Differences between Norwegian male and female preschool staff physical activity levels and their influence on PA levels of children. *Education 3-13*, 1. https://doi.org/10.1080/03004279.2021.2010228

Leggett, N., & Newman, L. (2017). Play: Challenging educators' beliefs about play in the indoor and outdoor environment. *Australasian Journal of Early Childhood*, *42*(1), 24. https://doi.org/10.23965/AJEC.42.1.03

Nilsen, A. K. O., Anderssen, S. A., Resaland, G. K., Johannessen, K., Ylvisaaker, E., & Aadland, E. (2019). Boys, older children, and highly active children benefit most from the preschool arena regarding moderate-to-vigorous physical activity: A cross-sectional study of Norwegian preschoolers. *Preventive Medicine Reports*, *14*, 100837. https://doi.org/10.1016/j.pmedr.2019.100837

Nilsen, A. K. O., Anderssen, S. A., Ylvisaaker, E., Johannessen, K., & Aadland, E. (2019). Moderate-to-vigorous physical activity among Norwegian preschoolers varies by sex, age, and season. *Scandinavian Journal of Medicine & Science in Sports*, *29*(6), 862. https://doi.org/10.1111/sms.13405

The Norwegian Directorate for Education and Training, *The Norwegian Education Mirror, 2019*. [cited. 2022a 09 02] Available from: https://www.udir.no/in-english/education-mirror-2019/school/#staff

The Norwegian Directorate for Education and Training, *Proportion of men in kindergartens, 2020*. [cited. 2022b 09 02] Available from: https://www.udir.no/tall-og-forskning/statistikk/statistikk-barnehage/andel-menn-i-barnehager/

O'Brien, K. T., Vanderloo, L. M., Bruijns, B. A., Truelove, S., & Tucker, P. (2018). Physical activity and sedentary time among preschoolers in centre-based childcare: A systematic review. *The International Journal of Behavioral Nutrition and Physical Activity*, *15*(1), 117. https://doi.org/10.1186/s12966-018-0745-6

Rajalahti, T., Arneberg, R., Berven, F. S., Myhr, K. -M., Ulvik, R. J., & Kvalheim, O. M. (2009). Biomarker discovery in mass spectral profiles by means of selectivity ratio plot. *Chemometrics and Intelligent Laboratory Systems*, *95*(1), 35. https://doi.org/10.1016/j.chemolab.2008.08.004

Rajalahti, T., Arneberg, R., Kroksveen, A. C., Berle, M., Myhr, K. -M., & Kvalheim, O. M. (2009). Discriminating variable test and selectivity ratio plot: quantitative tools for interpretation and variable (biomarker) selection in complex spectral or chromatographic profiles. *Analytical Chemistry*, *81*(7), 2581. https://doi.org/10.1021/ac802514y

Rajalahti, T., & Kvalheim, O. M. (2011). Multivariate data analysis in pharmaceutics: A tutorial review. *International Journal of Pharmaceutics*, *417*(1–2), 280. https://doi.org/10.1016/j.ijpharm.2011.02.019

Sabol, T. J., & Pianta, R. C. (2012). Recent trends in research on teacher–child relationships. *Attachment & Human Development*, *14*(3), 213. https://doi.org/10.1080/14616734.2012.672262

Sallis, J. F., Bull, F., Guthold, R., Heath, G. W., Inoue, S., Kelly, P., Oyeyemi, A. L., Perez, L. G., Richards, J., & Hallal, P. C. (2016). Progress in physical activity over the Olympic quadrennium. *The Lancet*, *388*(10051), 1325. https://doi.org/10.1016/S0140-6736(16)30581-5

Sandberg, A., & Pramling-Samuelsson, I. (2005). An interview study of gender difference in preschool teachers' attitudes toward children's play. *Early Childhood Education Journal*, *32*(5), 297. https://doi.org/10.1007/s10643-005-4400-x

Statistics Norway. *Kindergartens: Number of children in kindergarten*. [cited. 202108 02]; Available from: https://www.ssb.no/en/utdanning/barnehager/statistikk/barnehager

Tandon, P. S., Saelens, B., Zhou, C., & Christakis, D. (2018). A comparison of preschoolers' physical activity indoors versus outdoors at child care. *International Journal of Environmental Research and Public Health*, *15* (11), 2463. https://doi.org/10.3390/ijerph15112463

Tonge, K. L., Jones, R. A., & Okely, A. D. (2016). Correlates of children's objectively measured physical activity and sedentary behavior in early childhood education and care services: A systematic review. *Preventive Medicine*, *89*, 129. https://doi.org/10.1016/j.ypmed.2016.05.019

Tonge, K. L., Jones, R. A., & Okely, A. D. (2020). Environmental influences on children's physical activity in early childhood education and care. *Journal of Physical Activity & Health*, *17*(4), 423. https://doi.org/10.1123/jpah.2019-0119

Tonge, K. L., Jones, R. A., & Okely, A. D. (2021). The relationship between educators' and children's physical activity and sedentary behaviour in early childhood education and care. *Journal of Science and Medicine in Sport*, *24*(6), 580. https://doi.org/10.1016/j.jsams.2021.02.003

Troiano, R. P., BERRIGAN, D., DODD, K. W., Mâsse, L. C., TILERT, T., & MCDOWELL, M. (2008). *Physical activity in the United States measured by accelerometer*. Medicine and science in sports and exercise. *Medicine & Science in Sports & Exercise*, *40*(1), 181. https://doi.org/10.1249/mss.0b013e31815a51b3

Truelove, S., Bruijns, B. A., Vanderloo, L. M., O'Brien, K. T., Johnson, A. M., & Tucker, P. (2018). Physical activity and sedentary time during childcare outdoor play sessions: A systematic review and meta-analysis. *Preventive Medicine*, *108*, 74. https://doi.org/10.1016/j.ypmed.2017.12.022

Veldman, S. L. C., Chin, M. J. M., & Altenburg, T. M. (2021). Physical activity and prospective associations with indicators of health and development in children aged <5 years: A systematic review. *The International Journal of Behavioral Nutrition and Physical Activity*, *18*(1), 6. https://doi.org/10.1186/s12966-020-01072-w

WHO. (2019). *Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age*. World Health Organization (WHO).

WHO. (2020). *WHO guidelines on physical activity and sedentary behaviour*. World Health Organization.

Wold, S., Ruhe, A., Wold, H., & Dunn, I. W. J. (1984). The collinearity problem in linear-regression – the partial least squares (PLS) approach to generalized inverss. *Siam Journal on Scientific and Statistical Computing*, *5*(3), 735. https://doi.org/10.1137/0905052

Ylvisåker, E., Nilsen, A. K. O., Johannessen, K., & Aadland, E. (2021). The role of weather conditions on time spent outdoors and in moderate-to-vigorous physical activity among Norwegian preschoolers. *Journal of Sports Sciences*, *40*(1), 1. https://doi.org/10.1080/02640414.2021.1976490