Author(s): Luukkainen, Nanne-Mari; Laukkanen, Arto; Niemistö, Donna; Kotkajuuri, Jimi; Meklin, Elina; Sääkslahti, Arja

Title: Longitudinal relationship between organised and non-organised physical activities and overall physical activity in children aged 3–11 years

Year: 2024

Version: Published version

Please cite the original version:

Luukkainen, N., Laukkanen, A., Niemistö, D., Kotkajuuri, J., Meklin, E., & Sääkslahti, A. (2024). Longitudinal relationship between organised and non-organised physical activities and overall physical activity in children aged 3–11 years. European Journal of Sport Science, 24(8), 1197-1206. https://doi.org/10.1002/ejsc.12172

Received: 13 June 2023 | Revised: 25 March 2024 | Accepted: 10 July 2024

DOI: 10.1002/ejsc.12172

ORIGINAL PAPER

Official ECSS Journal Open Access WILEY

Longitudinal relationship between organised and non-organised physical activities and overall physical activity in children aged 3–11 years

Nanne-Mari Luukkainen | Arto Laukkanen | Donna Niemistö | Jimi Kotkajuuri | Elina Meklin | Arja Sääkslahti

Faculty of Sport and Health Sciences, University of Jyväskylä, Jyvaskyla, Finland

Correspondence
Nanne-Mari Luukkainen, Faculty of Sport and Health Sciences, University of Jyväskylä, P.O. Box 35 (L235), Jyvaskyla 40014, Finland.
Email: nanne-mari.n-m.luukkainen@jyu.fi

Funding information
Finnish Ministry of Education and Culture, Grant/Award Numbers: OKM/48/626/2014, OKM/59/626/2017

Abstract

Young children's physical activity (PA) has been decreasing while their sports participation has been increasing. Therefore, the aim of this research was to longitudinally examine whether and, if so, how organised and non-organised PA participation by early childhood education and care (ECEC)-aged children (T1; 3–8 years) predicted their accelerometer-measured PA at primary school age (T2; 7–11 years). Secondarily, changes in organised and non-organised PA participation over time were investigated. The cluster-randomised study participants comprised 501 Finnish children (52.3% girls: T1, $M_{age} = 5.57 \pm 1.06$; T2, $M_{age} = 8.80 \pm 1.07$). PA participation was queried via guardian questionnaire at T1 and T2. Organised PA participation was operationalised as non-participation, participation in one sport or multisport (two or more) participation; non-organised PA was operationalised as time spent outdoors on weekdays and on weekend days. PA at T2 was measured using accelerometers. The primary outcome was tested using linear regressions, while a paired sample *t*-test and Mann–Whitney *U* test assessed differences between T1 and T2. The results showed outdoor time and organised sports participation increased from T1 to T2. Moreover, outdoor time at T1 predicted more moderate-to-vigorous PA (MVPA) and less sedentary time at T2, while multisport participation predicted significantly more MVPA and less sedentary time at T2. Overall, being outdoors and multisport participation at younger ages appear to have predicted Finnish children's later (MV) PA and sedentary behaviour.

KEYWORDS
childhood, moderate-to-vigorous physical activity, multisport, organised sport, outdoor time, sedentary time

Highlights

- Outdoor time and multisports in early childhood positively predicted subsequent physical activity (PA) in middle childhood.

- Spending more than 30 min a day outdoors of ECEC hours predicted higher subsequent MVPA and lower sedentary time at school age.
- Adults promoting outdoor activities and multisports support children to adopt a physically active lifestyle.

1 | INTRODUCTION

PA—which is defined as any skeletal muscle movement and accumulates overall PA, thereby requiring energy expenditure—benefits physical, cognitive and mental health in multiple ways (Janssen et al., 2010; Poitras et al., 2016; Warburton et al., 2017; World Health Organization, 2022). Because PA is essential for good health, World Health Organization (WHO) developed global PA recommendations for children under 5 years old (World Health Organization, 2019) and for children 5–17 years old (World Health Organization, 2020). Approximately 27%–33% of children under age 7 did not engage in the recommended 1 hour daily of moderate-to-vigorous PA (MVPA) (Kämppi et al.). Moreover, these results of a Finnish studies showed that, beginning at age 7, children's PA levels begin to decline as a function of age; approximately half of the 7- to 12-year-old population did not meet the recommended amount of MVPA daily (Kämppi et al.). Similar to these findings, evidence shows children's PA has decreased worldwide in recent decades (Bassett et al., 2015; Conger et al., 2022; Dollman et al., 2005; Kyttä et al., 2015). On the other hand, it is known that a physically (in)active lifestyle begins to develop in early childhood, and tends to track through youth and into adulthood (Lounassalo et al., 2019; Telama et al., 2014). Typically, PA has been measured according to participation in organised sports and non-organised PA, such as physically active outdoor play (Telama et al., 2014). However, little is known about the function of participating in different forms of PA, such as organised and non-organised, in predicting PA in later childhood.

Before reaching school age, children most commonly engage in physically active play as their PA, while outdoor play, in particular, may be related to greater amounts of PA (Truelove et al., 2017). According to a Finnish school-based study, in spring 2018, the most prevalent form of PA that children aged 9–15 self-reported engaging in was non-organised PA, or independent PA; most young people (91%) moved independently at least once weekly (Kokko et al., 2019). The Finnish Report Card indicated 67%–73% of Finnish children aged 12 and younger engaged in non-organised PA nearly every day (Kämppi et al.); a claim supported by international research findings (García Bengoechea et al., 2010) showed that non-organised PA was more common than organised PA. At the same time, previous studies have demonstrated that 3- to 12-year-old children's leisure time outdoor independent mobility and outdoor play have both decreased in recent decades (Bassett et al., 2015; Kyttä et al., 2015), which is worrying because outdoor activities have been positively linked to children's health and development (Johnstone et al., 2022a, 2022b; Schaefer et al., 2014). Nevertheless, many children's free play and independent mobility are limited due to the lack of security or facilities (Veitch et al., 2006). Research has also revealed that outdoor time is positively linked with PA and MVPA and negatively with sedentary time in children (Gray et al., 2015; Sallis et al., 2000) and youth (Schaefer et al., 2014). However, inconsistent association with MVPA were found among children in nature-based ECEC compared to children attending traditional ECEC (Johnstone, McCrorie, et al., 2022). Meanwhile, a systematic review demonstrated that 3- to 12-year-old children, on average, achieved higher levels of PA and engaged in less sedentary time outdoors than indoors (Gray et al., 2015). Another study suggested that participation in organised outdoor sports is associated with a better health-related quality of life compared to participation in organised indoor sports (Moeijes et al., 2019).

Children's participation in organised activities, including sports activities, increased in Norway from 2005 to 2013/2014, especially among children aged 6–12 years (Nordbakke, 2019). Similar findings have also been observed in other studies (Bassett et al., 2015; Kokko et al., 2019). In addition, the proportion of children who have never played organised sports and the average age at which children first participate in organised sports both decreased from 2014 to 2018 (Kokko et al., 2019). As children's levels of outdoor mobility and outdoor play have diminished (Bassett et al., 2015; Kyttä et al., 2015), sports clubs may assume greater responsibility for children's daily PA. The association between sports participation and physical fitness is stronger in youth who regularly participate in sports clubs or organised sports activities compered to their peers who participate irregularly (Drenowatz et al., 2019). This association grows stronger with age; similarly, research has shown it to be less evident in children under 10 years of age (Drenowatz et al., 2019). While evidence also links participation in organised sports and better health-related quality of life in children aged 8–12 years (Moeijes et al., 2019), this participation was not associated with changes in psychosocial development a year later (McNeill et al., 2020). Based on the results of their study, Chen et al. (2020) reported that 3- to 5-year-old children's participation in organised sports related cross-sectionally to a 10% (6.0 min) increase in MVPA on average when compared to the MVPA of same-aged children who did not participate in organised sports. Although from a cross-sectional perspective, participation in sports increased MVPA more than non-participation did, from a longitudinal viewpoint, children's participation in sports was not associated with higher MVPA levels (Ikeda et al., 2022). However, little is known about the longitudinal connection between organised sports participation and PA in early childhood education and care (ECEC)-aged children and their PA levels in later childhood. Of course, it has been observed that sport participation was greater in the most physically active children at ECEC age, while differences were no longer observed at school age (Reisberg et al., 2021). Furthermore, research has illustrated that children spend a considerable portion of their day engaged in sedentary behaviour (~40%) and light PA (LPA) (~15%), with only 5% dedicated to MVPA (Chaput et al., 2014). As such, the relationship between young people's participation in organised and non-organised PA and their time spent engaged in PA of varied intensities must be examined.

Children's simultaneous participation in multiple organised sports, or 'multisport participation', is associated with a more physically active adulthood and with preventing non-participation in PA in the long term (Côté et al., 2009; Gallant et al., 2022). Cote and colleagues (Côté et al., 2009) discussed a related concept using the term 'sampling', defined as engaging in a variety of sports during childhood. Research findings demonstrate that multisport participation offers children more enjoyable experiences and results in fewer sports injuries than specialising in one sport from an early age (Côté et al., 2009). Early sport specialisation has also been linked to an increased risk of overtraining and burnout and reduced motor skill diversity (Lloyd et al., 2015).

Previous cross-sectional evidence shows that both organised and non-organised PA are needed to gain overall PA; however, the way children's participation in such activities explains changes in their PA levels over time remains unknown. In addition, despite the availability of both cross-sectional data on children's outdoor activities and the results of longitudinal studies involving young children, data on children's organised PA are limited. This includes data on the organised and non-organised PA of young children from a longitudinal perspective. For these reasons, this is an appropriate subject for academic research. From the socio-ecological perspective, the factors interacting with children's PA are multilevel (Mehtälä et al., 2014). Consequently, research knowledge on predictors of children's PA provides important information to families, ECEC, schools, sport club organisers, coaches and policymakers.

The primary aim of the research was to longitudinally examine whether and, if so, how participation in organised and non-organised sports by early childhood education and care (ECEC)-aged children (T1; 3–8 years) predicted accelerometer-measured PA at primary school age (T2; 7–11 years). The secondary aim was to investigate changes in the amount of time spent outdoors and in the level of sports participation between ECEC-aged and primary school-aged children. Based on previous cross-sectional studies (Gray et al., 2015; Sallis et al., 2000; Schaefer et al., 2014), we hypothesised that outdoor time for children of ECEC age would positively predict PA at primary school age. Our second hypothesis was that outdoor time would decrease (Bassett et al., 2015; Kyttä et al., 2015) and sports participation would increase (Kokko et al., 2019; Nordbakke, 2019) from T1 to T2.

2 | MATERIALS AND METHODS

2.1 | Study design

This longitudinal investigation was based on data from two studies: the Skilled Kids study (Time one [T1], 2015–2016) and Active Family study (Time two [T2], 2018–2020). At T1, 37 ECEC units selected from the Finnish National Registry of Early Educators were cluster-randomised throughout Finland from 24 localities based on their geographical location and residential density (Niemistö, 2021). Geographic locations (Southern, Central and Northern Finland) were based on postal codes, where the number of ECEC in each area was weighted by the area's population density (metropolitan area, cities, rural areas and countryside) (Niemistö, 2021). Approximately 3 years after T1 data collection, the same participants were invited to take part in the follow-up study (T2) of primary school-age children (7–11 years). A total of 950 children and their guardians, who had complete data on the main study variables at T1, were invited to participate in T2. Of those, 675 participated (participation rate ~71%), and to the present study 501 children were included. Inclusion criteria were the availability of valid data on the study variables at both T1 (parental questionnaire) and T2 (valid accelerometer data) and consent to aggregate the T1 and T2 datasets. The regression model involved 497 participants because those with any missing questionnaire data were excluded from the analysis. The ethical committee of University of Jyväskylä gave ethical approval for the T1 study on October 31, 2015, and for the T2 study on June 28, 2018. Guardians' written informed consent to participate were obtained before participation commenced.

2.2 | Anthropometry

Children were barefoot and wearing gym clothes when their height (cm) and body weight (kg) were measured at both timepoints. Height (Charder HM 200P) was measured to the nearest 0.1 cm, and weight (Seca 877) to the nearest 0.1 kg. These data were used to calculate body mass index (BMI; kg/m^2). BMI was based on BMI standard deviation scores (SDSs), calculated according to Finland's national standards for children (Saari et al., 2011). The raw BMI SDSs were used in the analysis.

2.3 | Guardian questionnaire

Children's guardians completed a questionnaire, providing information regarding their children's time outdoors, age, sex, socioeconomic status (guardians' education, income level and family status) and participation in organised sports, which they returned to the ECEC facility before data collection began. Child's sex (1 = girl, 2 = boy) was asked at both T1 and T2. Exact age was calculated as a difference between the child's guardian-reported date of birth and the date the children's measurements took place.

Outdoor time during the week and on weekends were investigated using the following questions: 'On average, how much time does your child spend outdoors on weekdays after the ECEC day/school day?' and 'How much time does your child spend outdoors on weekends?'. Response options were none (0), less than 30 min/d (1), about 30–60 min/d (2), more than 60 min/d (3), 1–2 h/d (4) and more than 2 h/d on weekends (5). Data on children's participation in organised sports were gathered with the following yes/no question: 'Does your child engage in organised sports in any group or sports club?'. Guardians responding 'yes' were asked to specify content and frequency. Based on the number of sports involved, the sports participation category was divided into three subgroups, no participation, one sport or multisport (two or more) participation. In addition, three subgroups were defined according to the type of sport, individual sport (only individual sport-related hobby), team sport (only team sport-related hobby) and the two combined (individual and team sport-related hobbies). A three-week test-retest reliability of outdoor time (ICC = 0.62; 95% CI = −0.12–1.0) and sports participation (ICC = 0.81; 95% CI = 0.60–0.91) was explored in a separate sample of 30 guardians at T1 (Niemistö, 2021).

2.4 | PA with accelerometers

In T2, triaxial accelerometers (RM42, UKK Terveyspalvelut Oy, Tampere, Finland; 100 Hz, 13-bit, ±16 g) measured children's overall PA. Children were encouraged to wear the accelerometer attached to an elastic belt on the right side of the hip for 7 days (Trost et al., 2000), excluding sick days. The belt was put on immediately upon waking up and removed when washing or swimming and at bedtime. Data for at least two weekdays, one weekend day and for 10 h each day was required to be included in analyses.

Activity levels were assessed by intensity using the mean amplitude deviation (MAD in mg) method, which enables the comparison of the findings of multiple studies (Vähä-Ypyä et al., 2015). Non-wear time for accelerometer was defined as MAD of the acceleration below 0.02 g for 60-min or longer period. MAD values based on nonoverlapping 5-s epochs of raw accelerometer data were computed using MATLAB R2021b (MathWorks, Natick, Massachusetts, USA). Furthermore, minutes spent engaged in sedentary behaviour, LPA and MVPA were calculated based on validated limit values for sedentary behaviour (<29 mg) and for light (≥29 mg), moderate (>338 mg) and vigorous (>604 mg) PA (Aittasalo et al., 2015). These intensity levels have been successfully applied to study children (Aittasalo et al., 2015). The records for the time when the device was removed, including the hours of 10 p.m. through 6 a.m., were removed from the data with MATLAB R2021b.

2.5 | Statistical analysis

Descriptive statistics, means and standard deviations (*SD*) were calculated for the child participants' data (age, height, weight, BMI SDS, PA, outdoor time and participation in organised sports); changes from T1 to T2 were tested using the paired sample *t*-test (BMI) or Wilcoxon Signed Ranks test (age, height, weight and sport participation time per week) (Table 1). We calculated the effect sizes of the statistically significant differences in the background variables. The Mann–Whitney *U* test was used to calculate the significant differences in PA levels in children participating in different type of sport (individual or team sport). Moreover, changes in the frequency of outdoor time between the two measurement points were calculated using a two-proportion *z*-test.

The linear regression model with enter method was used to investigate which of the explanatory variables—namely sex, age, outdoor time and number of organised sports activities—at T1 predicted children's PA (sedentary, LPA, MVPA) at T2. In these models, outdoor time was divided into three dummy variables, separately considering outdoor time during the week (<30 min/d, 30–60 min/d, >60 min/d) and on weekends (<60 min/d, 1–2 h/d, >2 h/d). The reference values for outdoor time were <30 min/d during the week and <60 min/d on weekends, and the value for participation in organised sports was non-participation. Additionally, child's BMI and family's socioeconomic status were used as covariates in the models, if found statistically significant. IBM SPSS Statistics version 26.0. Was used for data analysis; the statistical significance level was set at $p < 0.05$ in all statistical tests.

3 | RESULTS

The analysis included data on 501 participants (52.3% girls, 47.7% boys; $M_{age} = 5.57 \pm 1.06$ at T1, $M_{age} = 8.80 \pm 1.07$ at T2) (Table 1).

Outdoor time during the week varied more than during the weekend from T1 to T2 (Table 2). The increase in weekday time spent outdoors was especially notable in the increased proportion of children (43.4%) spending more than an hour outdoors on weekdays ($p < 0.001$). Additionally, a comparison of T1 and T2 data showed that the number of children spending over 2 hours outdoors in weekend increased statistically significantly, while the number spending 1–2 h outdoors decreased.

Over half (59.3%) of ECEC-aged children participated in organised sports: that number increased from 17.8% ($p < 0.001$) to 77.1% for school-aged children (Table 2). Participation in sports was divided into individual sport (T1: 69.5%, T2: 47.1%), team sport (T1: 18.0%, T2: 35.5%) and the two combined (T1: 12.5%, T2: 17.4%). Individual and team sports (T1) did not differ regarding children's light-to-vigorous PA (LVPA; individual sport: 455.2 ± 60.4, team sport: 452.2 ± 53,6 min, $p = 0.954$), although children participating in team sports demonstrated higher levels of MVPA (T2, individual sport: 166.9 ± 42.6, team sport: 181.2 ± 43,3 min, $p < 0.05$), while those engaged in individual sports exhibited higher levels of LPA (T2, individual sport: 288.3 ± 44.5, team sport: 271.0 ± 36,7 min, $p < 0.01$). Moreover, the fourth category—multisport (≥2 sports) participation—increased with age (T1: 34.9%, T2: 42.9%; $p < 0.05$).

When accelerometer-measured PA was predicted using regression models, children's age, sex, outdoor time and organised sports participation at T1 significantly explained variabilities in sedentary time (model 1, 15.5%), LPA (model 2, 15.0%) and MVPA (model 3, 18.4%) (Table 3) at T2. BMI and socioeconomic variables were dropped from the final models because they had no significant effect. The more time children spent outdoors or participated in multiple

TABLE 1 Comparison of participant characteristics at timepoints 1 and 2.

	n[c] T1 (T2)	T1 *M* ± *SD*	T2 *M* ± *SD*	*p*-value (T1–T2)	Skewness (T1) Value (SE)	Kurtosis (T1) Value (SE)	Skewness (T2) Value (SE)	Kurtosis (T2) Value (SE)	Effect size
Age (years)	501	5.57 ± 1.06	8.80 ± 1.07	**<0.001**	−0.345 (0.143)[b]	−0.706 (0.286)[b]	0.037 (0.110)[a]	−0.828 (0.220)[b]	0.866
Girls	262	5.55 ± 1.05	8.78 ± 1.04	**<0.001**					
Boys	239	5.60 ± 1.07	8.82 ± 1.09	**<0.001**					
Height (cm)	465 (493)	114.51 ± 8.48	134.47 ± 8.37	**<0.001**	0.210 (0.143)[a]	−0.262 (0.286)[a]	0.298 (0.110)[b]	−0.191 (0.220)[a]	0.867
Girls	242 (258)	113.88 ± 8.36	133.77 ± 8.34	**<0.001**					
Boys	223 (235)	115.20 ± 8.58	135.24 ± 8.35	**<0.001**					
Weight (kg)	465 (490)	21.51 ± 4.43	32.03 ± 7.73	**<0.001**	1.144 (0.143)[b]	1.701 (0.286)[b]	1.220 (0.110)[b]	1.916 (0.220)[b]	0.866
Girls	242 (256)	21.43 ± 4.65	31.79 ± 8.02	**<0.001**					
Boys	223 (234)	21.60 ± 4.18	32.29 ± 7.41	**<0.001**					
BMI SDS	459 (490)	0.18 ± 1.05	0.21 ± 1.00	0.337	−0.031 (0.143)[a]	−0.164 (0.286)[a]	0.008 (0.110)[a]	−0.057 (0.220)[a]	0.687
Girls	237 (256)	0.22 ± 1.13	0.23 ± 1.00	0.636					
Boys	222 (234)	0.14 ± 0.97	0.18 ± 0.99	0.367					
Sedentary (min/d)	501	No data	334 ± 58				−0.079 (0.109)[a]	0.069 (0.218)[a]	
Girls	262	No data	336 ± 59						
Boys	239	No data	332 ± 58						
Light PA (min/d)	501	No data	282 ± 44				0.162 (0.109)[a]	0.173 (0.218)[a]	
Girls	262	No data	293 ± 41						
Boys	239	No data	270 ± 42						
Moderate PA (min/d)	501	No data	156 ± 36				0.263 (0.109)[b]	0.282 (0.218)[a]	
Girls	262	No data	146 ± 33						
Boys	239	No data	166 ± 37						
Vigorous PA (min/d)	501	No data	13 ± 10				1.636 (0.109)[b]	3.861 (0.218)[b]	
Girls	262	No data	11 ± 9						
Boys	239	No data	16 ± 11						
MVPA (min/d)	501	No data	169 ± 42				0.351 (0.109)[b]	0.305 (0.218)[a]	
Girls	262	No data	158 ± 38						
Boys	239	No data	182 ± 43						
Participation in organised sports, times per week	295 (379)	1.58 ± 0.90	2.39 ± 1.29	**<0.001**	1.850 (0.143)[b]	4.118 (0.286)[b]	0.937 (0.125)[b]	0.682 (0.250)[b]	0.599

(Continues)

TABLE 1 (Continued)

	n[c] T1 (T2)	T1 $M \pm SD$	T2 $M \pm SD$	p-value (T1–T2)	Skewness (T1) Value (SE)	Kurtosis (T1) Value (SE)	Skewness (T2) Value (SE)	Kurtosis (T2) Value (SE)	Effect size
Girls	160 (193)	1.53 ± 0.85	2.21 ± 1.17	**<0.001**					
Boys	135 (186)	1.64 ± 0.96	2.58 ± 1.39	**<0.001**					

Note: T1–T2: paired sample *t*-test (BMI) or the Wilcoxon Signed Ranks test (age, height, weight, sport participation times per week). Bold values indicate $p < 0.05$.

Abbreviations: BMI SDS, body mass index standard deviation scores; M, mean; MVPA, moderate-to-vigorous physical activity; PA, physical activity; SD, standard deviation; T1, timeline 1 (early childhood, 3–7 years old); T2, timeline 2 (middle childhood, 7–11 years old).

[a]Skewness or kurtosis was normally distributed (<|2|).

[b]Skewness or kurtosis was non-normally distributed (>|2|).

[c]T2 reported if different from T1.

TABLE 2 Prevalence of children's outdoor time and organised sports participation at timepoints 1 and 2.

	T1 (%)	T2 (%)	% change (T1 to T2)	p-value
Outdoor time				
During the week				
None at all	3.0	0.6	−2.4	**0.005**
Less than 30 min/d	23.8	4.8	−19.0	**<0.001**
About 30–60 min/d	58.3	36.2	−22.1	**<0.001**
More than 60 min/d	15.0	58.4	43.4	**<0.001**
On the weekend				
None at all	0	0	0.0	
Less than 30 min/d	1.0	2.0	1.0	0.187
About 30–60 min/d	9.8	9.9	0.1	0.968
1–2 h/d	49.6	39.7	−9.9	**0.002**
More than 2 h/d	39.6	48.4	8.8	**0.005**
Organised sports participation	59.3	77.1	17.8	**<0.001**
Girls	61.9	75.0	13.1	**<0.001**
Boys	56.5	79.4	22.9	**<0.001**

Note: p-value was calculated using a two-proportion z-test. Bold values indicate $p < 0.05$.

Abbreviations: T1, timeline 1 (early childhood, 3–7 years old); T2, timeline 2 (middle childhood, 7–11 years old).

sports, the less time they were sedentary at T2 (model 1). On the other hand, as age predicted sedentary levels, the older children were sedentary more often. Model 2 showed that outdoor time and organised sports participation were not statistically significant predictors of LPA, but LPA decreased significantly with age, and girls had significantly higher LPA levels than boys.

According to model 3, 30–60 min/d or >60 min/d of outdoor time at T1 predicted significantly more minutes spent engaged in MVPA at T2 than less than 30 min/d of outdoor time. Moreover, children who spent more than 2 h/d outdoors on weekend days had statistical significance for a higher MVPA ($p = 0.056$). Participation in one or no organised sport did not predict subsequent MVPA. However, the model showed that multisport participation predicted higher MVPA levels at T2. Sex and age predicted MVPA levels: boys engaged in more MVPA ($p < 0.001$) than girls, and younger children engaged in more MVPA ($p < 0.001$) than older children at T2.

4 | DISCUSSION

This study investigated longitudinally how participation in organised and non-organised sports in ECEC-aged children (T1, 3–8 years) predicted their accelerometer-measured PA at primary school age (T2, 7–11 years). We found that the amount of outdoor time in early childhood positively predicted subsequent PA. Specially, children who spent more time outdoors on weekdays in early childhood tended to engage in more MVPA and less sedentary behaviour at school age when the effect of confounding factors was considered. In

TABLE 3 Outdoor time and participation in organised sports as predictors of accelerometer-measured subsequent physical activity.

	Model 1 sedentary at T2			Model 2 light PA at T2			Model 3 MVPA at T2		
Variables at T1	**Unstandardised B**	**Std. Error**	***p*-value**	**Unstandardised B**	**Std. Error**	***p*-value**	**Unstandardised B**	**Std. Error**	***p*-value**
Constant	256.947	15.199		338.642	11.413		185.549	10.737	
Outdoor time during the week									
Less than 30 min/d	Ref.			Ref.			Ref.		
30–60 min/d	−15.932	6.188	**0.010**	1.935	4.647	0.677	12.043	4.372	**0.006**
More than 60 min/d	−29.645	8.919	**0.001**	−2.877	6.697	0.668	18.400	6.300	**0.004**
Outdoor time on weekend									
Less than 60 min/d	Ref.			Ref.			Ref.		
1–2 h/d	−8.046	8.558	0.348	10.557	6.426	0.101	0.503	6.045	0.934
More than 2 h/d	−15.616	9.296	0.094	12.853	6.980	0.066	12.589	6.567	0.056
Organised sports									
No participation	Ref.			Ref.			Ref.		
One sport	−10.817	5.574	0.053	6.854	4.186	0.102	7.341	3.938	0.063
Multisport	−20.465	6.777	**0.003**	3.166	5.089	0.534	14.812	4.787	**0.002**
Sex	−2.605	4.942	0.598	−23.682	3.711	**<0.001**	23.061	3.491	**<0.001**
Age	19.847	2.411	**<0.001**	−10.617	1.810	**<0.001**	−8.661	1.703	**<0.001**
R squared		15.5			15.0			18.4	

Note: Bold values indicate $p < 0.05$.

Abbreviations: MVPA, moderate-to-vigorous physical activity; PA, physical activity; ref, reference; T1, timeline 1 (early childhood, 3–7 years old); T2, timeline 2 (middle childhood, 7–11 years old).

addition, participation in one sport did not predict either subsequent PA or sedentary time, but participation in multisport during early childhood predicted higher MVPA levels and less sedentary time during middle childhood. In conclusion, both higher outdoor time and participation in multiple sports in early childhood seems to predict higher subsequent PA in middle childhood.

In the current study, the more time children spent outdoors in early childhood, the less sedentary and more physically active they were at school age. Previously, the association between time spent outdoors and PA has been found cross-sectionally (Gray et al., 2015; Sallis et al., 2000), but evidence on the longitudinal association is scarce (Johnstone, McCrorie, et al., 2022). Sedentary behaviour has proven to be more frequently exhibited indoors than outdoors (Gray et al., 2015; Pereira et al., 2019), while outdoor activities have been linked to reduced sedentary behaviour (Gray et al., 2015; Schaefer et al., 2014), as was also observed in this study. Outdoor environments offer more open space. These provide more varied environments for physically active play and games (Veitch et al., 2006). Children attracted to outdoor environments daily gradually adopt a physically active lifestyle and, thus, predict more PA later. This does not disprove the claim that children can be physically active while also engaged in significant sedentary time. From a longitudinal perspective, outdoor activity in early childhood may help to create physically active habits, such as being physically active after school and engaging in PA with peers or parents during leisure time. These habits, formed during early childhood (Lounassalo et al., 2019; Telama et al., 2014) and reflected through outdoor time may carry over into school age. The same kind of tracking phenomena has been found among inactive lifestyles. In fact, tracking for sedentary lifestyles may be even stronger than for physically active lifestyles (Lounassalo et al., 2019). However, outdoor time can create active habits that reduce sedentary behaviours such as sitting. Hence, spending more time outdoors, thereby possibly engaging in more PA, can predict less sedentary behaviour in later childhood.

Outdoor activity was not found to predict LPA in this study, even though weekend day LPA minutes were, on average, over 10 min greater in children with >60 min outdoor time compared to children with < than 60 min. Other studies have presented opposite results regarding the association of outdoor time and LPA minutes (Larouche et al., 2019; Schaefer et al., 2014). Evidence shows that LPA plays an important role from this point of view as well (Ikeda et al., 2022). Children's light outdoor play usually consists of standing and light movement, such as balancing and climbing, but LPA is not limited to the outdoors: it can easily be performed indoors also, unlike MVPA, for which high intensity activities, such as running, may be more possible in outdoor environments. In early childhood, both 30–60 min/d and more than 60 min/d of outdoor time during the week predicted significantly more minutes spent engaged in MVPA later. Thus, half an hour of outdoor activity after the ECEC day may be sufficient for an active lifestyle to emerge. On weekends, children should spend more than 2 h outdoors for the PA to convey significant information about an active lifestyle, assuming that MVPA reflects an active lifestyle.

Sports participation increased from ECEC age to school age. However, a Finnish study has shown that participation in sports events seems to decrease with age beginning at age 9 (Kokko et al., 2019). From ECEC to school age, the number and form of sports children engage in change as the popularity of team sports grows. In this study, the type of sport did not impact LVPA, despite the differences in the intensity by sports type. For that reason, the type of sports available should not limit children's PA. Multisport participation has been shown to prevent non-participation in sports later in life (Côté et al., 2009). Children's multisport involvement has often been mirrored through the development of elite athletes, for instance, by investigating which factors predict engagement and progress in sports careers (Côté, 1999). However, these studies have typically lacked the perspective of generic developmental issues, such as PA. This is contradictory given the fact that athletic development programmes are forced to prioritise the promotion of overall PA due to the vast prevalence of inactivity in the youth population and, thus, the decreased benefits of sports participation (Lloyd et al., 2015). Many athletes have also participated in other sports in addition to their main sport, which indicates that multisport participation is also important to becoming an elite athlete (Côté, 1999; Güllich et al., 2022). Our study results suggest that multisport participation is important to children's subsequent PA, or it may be that physically active children tend to participate in multiple sports already in early childhood. The frequency of sport participation may also be one of the factors why multisport predicted higher PA later, thus multisport children may engage in several divergent sports during the year adapting the seasonal variation (e.g., divergent summer and winter sport sports). Thus, their weekly sport hours may have not necessarily been greater than in a one sport practiced all year round. Taken together, the majority of children's PA occurs in activities other than those that are organised (Kokko et al., 2019; Truelove et al., 2017). Therefore, all adults close to the child must remember the importance of outdoor activities to promote their PA.

The strength of this study was unique the data, as only a few longitudinal studies have focussed on the role of organised and non-organised sports participation as determinants of PA levels in children. Another strength of this study is the age of the child participants, as studies conducted on young children are limited. The data collection was randomised, and the study was geographically comprehensive, which makes the data more generalisable.

A limitation of this study was the lack of accelerometer data for the first timepoint and a relatively low inclusion criteria used for accelerometer measurement days (2 weekdays and 1 weekend day). That would provide a good way to visualise the changes in PA from ECEC to school age and to reflect outdoor activity at ECEC age because outdoor time may include play, transportation and sedentary activities. On the other hand, the variability in PA intensity from sedentary to vigorous PA was remarkable among the children, supporting the analyses performed. In addition, both main predictors, outdoor time and participation in organised sport were based on parental proxy reports and should be interpreted with caution.

5 | CONCLUSION

In conclusion, our study revealed that spending over 30 min outdoors after ECEC day on weekdays and participating in multiple sports during early childhood both predicted higher MVPA in middle childhood. Outdoor activities provide a convenient means to increase children's PA. A deeper understanding of outdoor time and non-organised PA is crucial to bolster children's overall PA. Children have the right to an active lifestyle and should have access to free outdoor activities to promote their physical and mental well-being. In contrast, participation in organised sports during ECEC years does not appear to be a prerequisite for children's later PA. However, taking part in multiple organised sports may have a positive impact on subsequent PA. Further research is needed to understand how organised sports, outdoor activities and non-organised PA or exercise interacts and influences children's future PA levels.

ACKNOWLEDGEMENTS

We thank the Skilled Kids and Active Family participants and their families. Also, we thank all staff members for collecting data and the supercomputer of CSC, the Finnish IT Centre for Science, that calculated the data. This study was funded by the Finnish Ministry of Education and Culture [OKM/48/626/2014 and OKM/59/626/2017].

CONFLICT OF INTEREST STATEMENT

No conflict of Interest to disclose.

ORCID

Nanne-Mari Luukkainen https://orcid.org/0000-0002-3204-2905
Arto Laukkanen https://orcid.org/0000-0002-9722-0258
Donna Niemistö https://orcid.org/0000-0002-9198-9437
Jimi Kotkajuuri https://orcid.org/0000-0002-4195-8675
Elina Meklin https://orcid.org/0000-0001-7042-9038
Arja Sääkslahti https://orcid.org/0000-0003-4354-0990

REFERENCES

Aittasalo, M., H. Vähä-Ypyä, T. Vasankari, P. Husu, A. M. Jussila, and H. Sievänen. 2015. "Mean Amplitude Deviation Calculated from Raw Acceleration Data: A Novel Method for Classifying the Intensity of Adolescents' Physical Activity Irrespective of Accelerometer Brand." *BMC Sports Sci Med Rehabil* 7(1): 18. https://doi.org/10.1186/s13102-015-0010-0.

Bassett, D. R., D. John, S. A. Conger, E. C. Fitzhugh, and D. P. Coe. 2015. "Trends in Physical Activity and Sedentary Behaviors of United States Youth." *Journal of Physical Activity and Health* 12(8): 1102–11. https://doi.org/10.1123/jpah.2014-0050.

Chaput, J. P., V. Carson, C. E. Gray, and M. S. Tremblay. 2014. "Importance of All Movement Behaviors in a 24 Hour Period for Overall Health."

International Journal of Environmental Research and Public Health 11(12): 12575–81. https://doi.org/10.3390/ijerph111212575.

Chen, C., F. Sellberg, V. H. Ahlqvist, M. Neovius, F. Christiansen, and D. Berglind. 2020. "Associations of Participation in Organized Sports and Physical Activity in Preschool Children: A Cross-Sectional Study." *BMC Pediatrics* 20(1): 328. https://doi.org/10.1186/s12887-020-02222-6.

Conger, S. A., L. P. Toth, C. Cretsinger, A. Raustorp, J. Mitáš, S. Inoue, and D. R. Bassett. 2022. "Time Trends in Physical Activity Using Wearable Devices: A Systematic Review and Meta-Analysis of Studies from 1995 to 2017." *Medicine & Science in Sports & Exercise* 54(2): 288–98. https://doi.org/10.1249/mss.0000000000002794.

Côté, J. 1999. "The Influence of the Family in the Development of Talent in Sport." *The Sport Psychologist* 13(4): 395–417. https://doi.org/10.1123/tsp.13.4.395.

Côté, J., S. Horton, D. MacDonald, and S. Wilkes. 2009. "The Benefits of Sampling Sports during Childhood." *Physical and Health Education Journal* 74: 6–11.

Dollman, J., K. Norton, L. Norton, and V. Cleland. 2005. "Evidence for Secular Trends in Children's Physical Activity Behaviour." *British Journal of Sports Medicine* 39(12): 892–7. https://doi.org/10.1136/bjsm.2004.016675.

Drenowatz, C., K. Greier, G. Ruedl, and M. Kopp. 2019. "Association between Club Sports Participation and Physical Fitness across 6- to 14-Year-Old Austrian Youth." *International Journal of Environmental Research and Public Health* 16(18): 3392. https://doi.org/10.3390/ijerph16183392.

Gallant, F., R. M. Murray, C. M. Sabiston, and M. Bélanger. 2022. "Description of Sport Participation Profiles and Transitions across Profiles during Adolescence." *Journal of Sports Sciences* 40(16): 1824–36. https://doi.org/10.1080/02640414.2022.2115223.

García Bengoechea, E., C. M. Sabiston, R. Ahmed, and M. Farnoush. 2010. "Exploring Links to Unorganized and Organized Physical Activity during Adolescence: The Role of Gender, Socioeconomic Status, Weight Status, and Enjoyment of Physical Education." *Research Quarterly for Exercise & Sport* 81(1): 7–16. https://doi.org/10.5641/027013610x13352775119475.

Gray, C., R. Gibbons, R. Larouche, E. B. H. Sandseter, A. Bienenstock, M. Brussoni, G. Chabot, et al. 2015. "What Is the Relationship between Outdoor Time and Physical Activity, Sedentary Behaviour, and Physical Fitness in Children? A Systematic Review." *International Journal of Environmental Research and Public Health* 12(6): 6455–74. https://doi.org/10.3390/ijerph120606455.

Güllich, A., B. N. Macnamara, and D. Z. Hambrick. 2022. "What Makes a Champion? Early Multidisciplinary Practice, Not Early Specialization, Predicts World-Class Performance." *Perspectives on Psychological Science* 17(1): 6–29. https://doi.org/10.1177/1745691620974772.

Ikeda, E., J. M. Guagliano, A. J. Atkin, L. B. Sherar, U. Ekelund, B. Hansen, K. Northstone, et al. 2022. "Cross-sectional and Longitudinal Associations of Active Travel, Organised Sport and Physical Education with Accelerometer-Assessed Moderate-To-Vigorous Physical Activity in Young People: the International Children's Accelerometry Database." *International Journal of Behavioral Nutrition and Physical Activity* 19(1): 41. https://doi.org/10.1186/s12966-022-01282-4.

Janssen, I., and A. G. LeBlanc. 2010. "Systematic Review of the Health Benefits of Physical Activity and Fitness in School-Aged Children and Youth." *International Journal of Behavioral Nutrition and Physical Activity* 7(1): 40. https://doi.org/10.1186/1479-5868-7-40.

Johnstone, A., A. Martin, R. Cordovil, I. Fjørtoft, S. Iivonen, B. Jidovtseff, F. Lopes, et al. 2022. "Nature-Based Early Childhood Education and Children's Social, Emotional and Cognitive Development: A Mixed-Methods Systematic Review." *International Journal of Environmental Research and Public Health* 19(10): 5967. https://doi.org/10.3390/ijerph19105967.

Johnstone, A., P. McCrorie, R. Cordovil, I. Fjørtoft, S. Iivonen, B. Jidovtseff, F. Lopes, et al. 2022. "Nature-based Early Childhood Education and Children's Physical Activity, Sedentary Behaviour, Motor Competence and Other Physical Health Outcomes: A Mixed-Methods Systematic Review." *Journal of Physical Activity and Health* 19(6): 456–72. https://doi.org/10.1123/jpah.2021-0760.

Kämppi, K., P. Asunta, and T. Tammelin. Finland's Report Card 2022 on Physical Activity for Children and Youth 2022. LIKES Research Reports on Physical Activity and Health 407. JAMK University of Applied Sciences.

Kokko, S. and L. Martin. 2019. *Lasten Ja Nuorten Liikuntakäyttäytyminen Suomessa. [in Finnish] Liitu Tutkimuksen Tuloksia 2018*, Vol. 1. VLN.

Kyttä, M., J. Hirvonen, J. Rudner, I. Pirjola, and T. Laatikainen. 2015. "The Last Free-Range Children? Children's Independent Mobility in Finland in the 1990s and 2010s." *Journal of Transport Geography* 47: 1–12. https://doi.org/10.1016/j.jtrangeo.2015.07.004.

Larouche, R., E. F. Mire, K. Belanger, T. V. Barreira, J. P. Chaput, M. Fogelholm, G. Hu, et al. 2019. "Relationships between Outdoor Time, Physical Activity, Sedentary Time, and Body Mass Index in Children: A 12-Country Study." *Pediatric Exercise Science* 31(1): 118–29. https://doi.org/10.1123/pes.2018-0055.

Lloyd, R. S., J. L. Oliver, A. D. Faigenbaum, R. Howard, M. B. A. De Ste Croix, C. A. Williams, T. M. Best, et al. 2015. "Long-Term Athletic Development, Part 2: Barriers to Success and Potential Solutions." *The Journal of Strength & Conditioning Research* 29(5): 1451–64. https://doi.org/10.1519/01.jsc.0000465424.75389.56.

Lounassalo, I., K. Salin, A. Kankaanpää, M. Hirvensalo, S. Palomäki, A. Tolvanen, X. Yang, and T. H. Tammelin. 2019. "Distinct Trajectories of Physical Activity and Related Factors during the Life Course in the General Population: A Systematic Review." *BMC Public Health* 19(1): 271. https://doi.org/10.1186/s12889-019-6513-y.

McNeill, J., S. J. Howard, S. A. Vella, and D. P. Cliff. 2020. "Longitudinal Associations of Physical Activity and Modified Organized Sport Participation with Executive Function and Psychosocial Health in Preschoolers." *Journal of Sports Sciences* 38(24): 2858–65. https://doi.org/10.1080/02640414.2020.1803037.

Mehtälä, M. A. K., A. K. Sääkslahti, M. E. Inkinen, and M. E. H. Poskiparta. 2014. "A Socio-Ecological Approach to Physical Activity Interventions in Childcare: A Systematic Review." *International Journal of Behavioral Nutrition and Physical Activity* 11(1): 22. https://doi.org/10.1186/1479-5868-11-22.

Moeijes, J., J. T. van Busschbach, T. H. Wieringa, J. Kone, R. J. Bosscher, and J. W. R. Twisk. 2019. "Sports Participation and Health-Related Quality of Life in Children: Results of a Cross-Sectional Study." *Health and Quality of Life Outcomes* 17(1): 64. https://doi.org/10.1186/s12955-019-1124-y.

Niemistö, D. 2021. "Skilled Kids Around Finland: the Motor Competence and Perceived Motor Competence of Children in Childcare and Associated Socioecological Factors [Doctoral Dissertation]." *University of Jyväskylä. JYU Dissertations* 394(55): 69–71.

Nordbakke, S. 2019. "Children's Out-Of-Home Leisure Activities: Changes during the Last Decade in Norway." *Children's Geographies* 17(3): 347–60. https://doi.org/10.1080/14733285.2018.1510114.

Pereira, J. R., D. P. Cliff, E. Sousa-Sá, Z. Zhang, and R. Santos. 2019. "Prevalence of Objectively Measured Sedentary Behavior in Early Years: Systematic Review and Meta-Analysis." *Scandinavian Journal of Medicine & Science in Sports* 29(3): 308–28. https://doi.org/10.1111/sms.13339.

Poitras, V. J., C. E. Gray, M. M. Borghese, V. Carson, J. P. Chaput, I. Janssen, P. T. Katzmarzyk, et al. 2016. "Systematic Review of the Relationships between Objectively Measured Physical Activity and Health Indicators in School-Aged Children and Youth." *Applied Physiology Nutrition and Metabolism* 41(Suppl 3): S197–239. https://doi.org/10.1139/apnm-2015-0663.

Reisberg, K., E. M. Riso, and J. Jürimäe. 2021. "Physical Activity, Fitness, and Cognitive Performance of Estonian First-Grade Schoolchildren According Their MVPA Level in Kindergarten: A Longitudinal Study." *International Journal of Environmental Research and Public Health* 18(14): 7576. https://doi.org/10.3390/ijerph18147576.

Saari, A., U. Sankilampi, M. L. Hannila, V. Kiviniemi, K. Kesseli, and L. Dunkel. 2011. "New Finnish Growth References for Children and Adolescents Aged 0 to 20 Years: Length/height-For-Age, Weight-For-Length/height, and Body Mass Index-For-Age." *Annals of Medicine* 43(3): 235–48. https://doi.org/10.3109/07853890.2010.515603.

Sallis, J. F., J. J. Prochaska, and W. C. Taylor. 2000. "A Review of Correlates of Physical Activity of Children and Adolescents." *Medicine & Science in Sports & Exercise* 32: 963–75. https://doi.org/10.1097/00005768-200005000-00014.

Schaefer, L., R. C. Plotnikoff, S. R. Majumdar, R. Mollard, M. Woo, R. Sadman, R. L. Rinaldi, et al. 2014. "Outdoor Time Is Associated with Physical Activity, Sedentary Time, and Cardiorespiratory Fitness in Youth." *The Journal of Pediatrics* 165(3): 516–21. https://doi.org/10.1016/j.jpeds.2014.05.029.

Telama, R., X. Yang, E. Leskinen, A. Kankaanpää, M. Hirvensalo, T. Tammelin, J. S. A. Viikari, and O. T. Raitakari. 2014. "Tracking of Physical Activity from Early Childhood through Youth into Adulthood." *Medicine & Science in Sports & Exercise* 46(5): 955–62. https://doi.org/10.1249/mss.0000000000000181.

Trost, S. G., R. R. Pate, P. S. Freedson, J. F. Sallis, and W. C. Taylor. 2000. "Using Objective Physical Activity Measures with Youth: How Many Days of Monitoring Are Needed?" *Medicine & Science in Sports & Exercise* 32(2): 426. https://doi.org/10.1097/00005768-200002000-00025.

Truelove, S., L. M. Vanderloo, and P. Tucker. 2017. "Defining and Measuring Active Play Among Young Children: A Systematic Review." *Journal of Physical Activity and Health* 14(2): 155–66. https://doi.org/10.1123/jpah.2016-0195.

Vähä-Ypyä, H., T. Vasankari, P. Husu, J. Suni, and H. Sievänen. 2015. "A Universal, Accurate Intensity-Based Classification of Different Physical Activities Using Raw Data of Accelerometer." *Clinical Physiology and Functional Imaging* 35(1): 64–70. https://doi.org/10.1111/cpf.12127.

Veitch, J., S. Bagley, K. Ball, and J. Salmon. 2006. "Where Do Children Usually Play? A Qualitative Study of Parents' Perceptions of Influences on Children's Active Free-Play." *Health & Place* 12(4): 383–93. https://doi.org/10.1016/j.healthplace.2005.02.009.

Warburton, D. E. R., and S. S. D. Bredin. 2017. "Health Benefits of Physical Activity: A Systematic Review of Current Systematic Reviews." *Current Opinion in Cardiology* 32(5): 541–56. https://doi.org/10.1097/hco.0000000000000437.

World Health Organization. 2019. *Guidelines on Physical Activity, Sedentary Behaviour and Sleep for Children under 5 Years of Age*. Geneva: World Health Organization.

World Health Organization. 2020. *WHO Guidelines on Physical Activity and Sedentary Behaviour*. Geneva: World Health Organization.

World Health Organization. 2022. Physical Activity. https://www.who.int/news-room/fact-sheets/detail/physical-activity. Accessed Feb 7, 2023.