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Children's outdoor time and multisport participation predict motor competence three years later

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ABSTRACT
This study longitudinally examined, in a cluster-randomised data sample ($n = 627$, 3–11 years, 51.0% girls), how participation in organised and non-organised physical activity (PA) in early childhood (T1) predicted motor competence (MC) in middle childhood (T2). Organised sports participation and non-organised PA (outdoor time) were investigated via guardian questionnaire (T1, T2). At T2, children's MC was assessed using two locomotor (LMS) and two object control (OCS) skills from the Test of Gross Motor Development – 3rd edition measurement, for a total of four fundamental movement skills (FMS). The Körperkoordinationstest Für Kinder jumping sideways (JS) test was used. A linear regression model demonstrated that children's multisport participation at T1 predicted higher performance in LMS, OCS, FMS, and JS ($p < 0.001$ to $p = 0.003$; $R^2 = 16.4\%$ to 23.5%) at T2. Outdoor time on weekdays at T1 predicted higher JS ($p = 0.009$, 8.4%), OCS ($p = 0.006$, 14.5%) and FMS ($p = 0.003$, 10.0%) scores for girls. Two-way analysis of variance examined the interaction effects of sports participation and outdoor time on MC, but interactions were not found. These results underline the independent role of organised and non-organised sports participation in motor development from early to middle childhood.

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Introduction

Children's motor competence (MC) and participation in sports activities are beneficially associated with physical (Donnelly et al., 2016; Lubans et al., 2010; Robinson et al., 2015), psychological (Biddle & Asare, 2011; Donnelly et al., 2016; Eime et al., 2013; Lubans et al., 2010; Robinson et al., 2015; Rodriguez-Ayllon et al., 2019) and social (Eime et al., 2013; Lubans et al., 2010; Robinson et al., 2015) aspects of their development. Additionally, MC and health-related fitness have been shown to be interconnected throughout childhood (Luz et al., 2017; Robinson et al., 2015). Therefore, determining which childhood factors predict the development of MC is crucial. Understanding these factors is particularly important, as motor development can have a lasting impact on overall health, physical activity (PA) levels, and well-being throughout life.

The term MC has been used generally to represent motor performance, skills, ability and coordination (Robinson et al., 2015). In this study, we categorised MC into locomotor skills (LMS), object control skills (OCS) and fundamental movement skills (FMS). FMS, practised by children through play, presents as building blocks for more complex movements and serves as an integral aspect of fostering early childhood motor coordination (Goodway et al., 2019). MC, essential for a physically active lifestyle, is primarily established in childhood (Aaltonen et al., 2015; Hulteen et al., 2018), with development continuing throughout life (Brian et al., 2020). Motor competence develops with age (Bolger et al., 2021) through learning and practice (Brian et al., 2020).

Development of MC is relatively stable across childhood (Niemistö et al., 2020), while early deficits often persist into later life (Wilson et al., 2020). Hulteen and his colleagues (Hulteen et al., 2018) illustrated the interconnected development of MC and PA across the lifespan influenced by various physical and psychological factors (e.g. weight status, cardiorespiratory fitness, and perceived competence) (Hulteen et al., 2018). While several models (Côté et al., 2007; Stodden et al., 2008) have been linked to PA behaviour and MC development, Hulteen and his colleagues' framework (Hulteen et al., 2018) forms the foundations for examining the potential lifespan contribution between various forms of PA and movement skill development. Stodden's and his colleagues' model (Stodden et al., 2008) outlines a conceptual framework where developmental mechanisms influence children's the PA trajectories. Similarly, Developmental Model of Sport Participation emphasizes multiple pathways to engaging in both organised and non-organised PA.[16] On the other hand, individual and environmental factors shape MC development, and significant roles are also played by sociocultural and geographical contexts (Laukkanen et al., 2020), a perspective which is a key assumption in the model from Hulteen and his colleagues (Hulteen et al., 2018).

In the core of the Hulteen and his colleagues model is the sociocultural and geographical filter (Hulteen et al., 2018) through which motor skill development should be viewed. Sociocultural context and geographic location concerns the exposure of individuals to skills and the importance placed on learning a specific skill in different cultures. From this

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perspective, we suggest that organised and non-organised PA participation in children plays a crucial, sociocultural role in motor development.

The interaction between organised and non-organised PA refers to how these two forms of participation collectively influence MC. Over the years, the prevalence of organised sports participation has increased noticeably (Kemp et al., 2019; Mathisen et al., 2019; Nordbakke, 2019). For instance, the level of sports participation of both male and female 11-year-old youth in Finland and Norway grew from 1985/1986 to 2014 (Mathisen et al., 2019). Similarly, the sport participation rates of younger children (6–7 years old) rose from 2005 (76%) to 2013–2014 (91%) (Nordbakke, 2019). According to related study findings, the average age of children who began to participate in organised PA in Finland ranged between 6 and 7 years old from 2014–2022 (Blomqvist et al., 2019, 2023). Notably, a sizeable proportion of 3-year-old (35.9%) and 4-year-old (46.8%) children were already involved in organised PA (Niemistö et al., 2023). The similar upsurging trend in organised PA participation has been shown across studies (Kemp et al., 2019). Another trend indicates that while an average 60–69% of children aged 11–15 participate in organised PA across various European countries organised sports participation tends to decrease with age among 11–15-year-old youth (Kokko et al., 2019).

Moreover, participation in non-organised PA is even more prevalent compared to organised sports club participation (Blomqvist et al., 2019, 2023). Children's PA is mainly physical play (non-organised PA) during early childhood. In the context of non-organised PA, participation in active free play has not been linearly associated with age: it has been shown to increase from ages 10 to 12 but then decline until age 14 (Cairney et al., 2018). Nevertheless, research shows that outdoor time can improve MC (Kwon et al., 2022). For example, in one study, children aged 3–5 years old had higher OCS scores when they spent more time outdoors, but no association with LMS scores was found (Kwon et al., 2022). On the other hand, Field and Temple (Field & Temple, 2017) noticed that LMS and OCS were negatively correlated with active physical recreation in 9-year-olds, while in the preschool environment study time spent outdoors per day was not found to be a significant predictor of OCS, LMS or total MC in 3–5-year-olds (True et al., 2017).

Previous studies have identified a relationship between MC and sports participation (Lykkegaard et al., 2023). Specifically, research has shown that LMS are positively associated with organised sports participation among both 3–5-year-old (Henrique et al., 2016) and 9-year-old (Field & Temple, 2017) children. Among boys, OCS have been positively correlated with participation in team sports (Field & Temple, 2017). Additionally, participation in sports clubs has been linked to higher FMS scores among preschool-aged children (Iivonen & Sääkslahti, 2014). At the same time, gender differences have been observed in MC, particularly in various sports, in children around 9 years old (Field & Temple, 2017). Moreover, gender has not been found to predict sports participation in younger children aged 3–5 (Henrique et al., 2016). Furthermore, research suggests that the relationship between MC and sports participation extends beyond early childhood and into adolescence. For instance, longitudinal studies have shown that children with higher performance in MC during early childhood are more likely to continue participating in sports as they grow older (Lopes et al., 2011). Moreover, socioeconomic factors and access to PA facilities have also been found to influence sports participation among children (Määttä et al., 2016; Pandya, 2021). Studies have shown that children from lower socioeconomic backgrounds may have limited access to organised sports programmes and facilities, which can decrease their participation rates (Pandya, 2021). In line with these findings, Lykkegaard and colleagues (Lykkegaard et al., 2023) concluded that encouraging the development of children's MC from an early age may enhance the probability of their future engagement in leisure time sports. This underscores the importance of MC development in fostering long-term involvement in PA.

Children's organised and non-organised PA during early years evidently play a role in enhancing their motor competence (Stodden et al., 2008) and contributes to improved motor skills later in life (Barnett et al., 2022; Bürgi et al., 2011; Jones et al., 2020) Conversely, motor competence itself has been shown to predict levels of PA later in childhood (Kasanen et al., 2023). However, research is required to consider the independent role of both the organised and non-organised PA participation on motor development. Secondly, more information is needed on their interaction effects, as it remains unknown how the participation of either in organised or in non-organised PA, or in both predicts children's subsequent motor development. Overall, it is vital to determine whether PA and sport for young children needs to be organised, non-organised, or both of them together for the optimal development of MC.

This study investigated whether and how organised sports participation and the amount of time spent outdoors in early childhood predict children's MC in middle childhood. We researched both the main effects and interaction effects of organised sports participation and outdoor time on MC. In summary, understanding the relationship between MC, sports participation and outdoor time, especially in children, is crucial for developing effective strategies to promote motor development and healthy lifestyles.

Materials and methods

Study design and participants

The longitudinal study of the MC of children in Finland was cluster-randomised from 24 localities throughout the country based on their geographical location and residential density. At baseline, in the Skilled Kids study (Time one [T1], 2015–2016), 37 early childhood education and care (ECEC) units (children aged 3–8 years old) were selected from the Finnish National Registry of Early Educators (Niemistö, 2021). Approximately three years after T1 data collection, the same participants were invited to be included in the follow-up Active Family study (Time two [T2], 2018–2020) of primary school-age children (6–11 years old). In the studies, the children performed various MC measurements tasks, their body composition was measured, and a calculation of the time they spent outdoors and participating in organised sports was determined according to their guardians' questionnaire responses. Complete study data for the T1 main study variables were available for 950 children, who were invited through primary schools across the country to participate in the T2 research. Of those, 675 participated in the study (participation rate ~71%), and 627 were included in the final analysis. The two inclusion criteria were 1) consent to aggregate the T1 and T2 datasets and 2) the availability of valid data on the study variables at both T1 (guardian questionnaire) and T2 (MC) time points.

The University of Jyväskylä's ethical committee gave ethical approval for the T1 study on 31 October 2015 and for the T2 study on 28 June 2018. Before participation commenced, written informed consent was obtained from the children and their guardians.

Guardian questionnaire

Children's guardians completed a take-home questionnaire, providing information regarding their children's age, gender, socioeconomic status (guardians' education, income level, family status) and participation in organised sports, as well as information on the children's time spent outdoors on weekdays and weekend days (T1). Guardians returned completed questionnaires to their child's ECEC facility. Each child's exact age was calculated as the difference between the child's guardian-reported date of birth and the date when the child's measurements were taken for the study.

Test-retest reliability of the guardian questionnaire was shown to be acceptable for a separate sample of 195 guardians in a study regarding sports participation (ICC = 0.81; 95% CI = 0.75–0.85) and time spent outdoors during the week (ICC = 0.67; 95% CI = 0.58–-0.74) and on weekends (ICC = 0.74; 95% CI = 0.67–0.80) (Sääkslahti et al., 2021). 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 the content of the organised sports. Based on the number of various sports involved, sports participation was divided into three subcategories: non-participation, participation in one sport, and multisport participation (participation in two or more sports). 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/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) [where 'd' = 'day', 'h' = 'hours' and 'min' = 'minutes'].

Measurements

The children were barefoot and dressed in gym clothes when their height (Charder HM 200P; accuracy of 0.1 cm) and body weight (Seca 877; accuracy of 0.1 kg) were measured at both time points (T1 and T2). Children's MC was assessed using the Test of Gross Motor Development – 3rd edition (TGMD-3) measures (Ulrich, 2019) and the KTK-test (Kiphard & Kinder, 2007) focusing on specific subcategories performed by the children (T2). A shortened version of the TGMD-3 was used, where hopping (scale 0–8 points [p]) and skipping (scale 0–6 p) (=LMS measures) were assessed, as were one-hand stationary dribbling (scale 0–6 p) and overhand throwing (scale 0–8 p) (=OCS). These subtests were chosen because they effectively represented the LMS and OCS factors of the TGMD-3 (Wagner et al., 2017). A total LMS score ranged from 0–14 p, with a range of 0–14 p for OCS and 0–28 p for FMS scores. Balance is a prerequisite for all movement skills. Therefore, one KTK test item, jumping sideways, was chosen to represent dynamic balance. In accordance with the KTK test, sideways jumps were measured by counting the number of leaps the child completed in 15 seconds while hopping side to side (using the sum of the number of correct jumps in two trials).

Statistical analysis

Means and standard deviations were calculated using the child participants' data (age, height, weight, outdoor time, participation in organised sports and MC measurements); differences between girls and boys were investigated via the Mann-Whitney U test. Data were analysed using a linear regression model with the enter method to uncover which of the explanatory variables – that is, gender, age, time spent outdoors and/or the number of organised sports participated in – at T1 predicted children's MC (LMS, OCS, FMS) 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 reference value for participation in organised sports was non-participation. The children's socioeconomic statuses were tested as covariates, but they were not found to be statistically significant, so they were omitted from the final models.

The first analysis examined MC for jumping sideways with organised sports participation, outdoor time, age and gender (Model 1). Subsequent analyses examined LMS (Model 2), OCS (Model 3) and FMS (Model 4) with organised sports participation, outdoor time, age and gender. A two-way analysis of variance was performed with the Bonferroni post-hoc test to examine interaction effects: participation (non-participation, one sport, multisport) * outdoor time on weekdays (<30 min/d, 30–60 min/d, > 60 min/d). IBM SPSS Statistics version 28.0. was used for data analysis; the statistical significance level was set at $p < 0.05$ in all statistical tests.

Results

A total of 627 children aged 5.5 ± 1.1 (T1) and 8.7 ± 1.1 (T2) years old (51.0% girls) were included in the study sample. Descriptive characteristics at the baseline and follow-up time points are presented in Table 1. Boys spent significantly more time outdoors on weekdays compared to girls (T1, $p = 0.004$). However, no significant differences were observed between the two genders' outdoor time on weekends. Meanwhile, girls showed a slightly higher prevalence of participation in organised sports compared to boys. The frequency of children's weekly organised PA ranged from 0 to 6 times per week, with an average of 1.6 ± 0.9 sessions per week. On average, each session lasted 56 ± 19 minutes. Furthermore, significant gender differences were observed: boys exhibited higher performance

Table 1. Basic characteristics of the participants.

N	Variables	All	Girls (51.0%)	Boys	Between genders p-value
T1: BASELINE					
627	Age (yr.)	5.5 (1.1)	5.5 (1.1)	5.6 (1.1)	0.211
576	Body weight (kg)	21.5 (4.5)	21.3 (4.8)	21.6 (4.2)	0.123
576	Height (cm)	114.2(8.7)	113.3 (8.5)	115.2 (8.8)	**0.012***
627	Outdoor time week (%)	2.9	3.4	2.3	**0.004***
	none at all	22.8	26.3	19.2	
	less than 30 min/d	58.1	57.2	59.0	
	about 30–60 min/d	16.3	13.1	19.5	
	more than 60 min/d				
627	Outdoor time weekend (%)	0	0	0	0.064
	none at all	1.0	1.6	0.3	
	less than 30 min/d	10.4	13.4	7.2	
	about 30–60 min/d	48.8	46.9	50.8	
	1–2 h/d	39.9	38.1	41.7	
	more than 2 h/d				
627	Participation in organised sport (%)	56.3	60.0	52.4	0.057
	no participation	43.9	40.0	47.9	
	one sport	38.1	40.3	35.8	
	multisport	18.0	19.7	16.3	
T2: FOLLOW-UP					
627	Age (yr.)	8.7 (1.1)	8.7 (1.1)	8.8 (1.1)	0.246
618	Body weight (kg)	31.9 (7.8)	31.6 (8.1)	32.2 (7.4)	0.135
622	Height (cm)	134.1 (8.5)	133.2 (8.4)	135.1 (8.4)	**0.007***
627	Hop (scale 0–8)	5.57 (1.80)	5.58 (1.60)	5.56 (1.99)	0.629
627	Skip (scale 0–6)	3.35 (1,90)	3.89 (1.56)	2.79 (2.06)	**<0.001***
627	LMS total (0–14)	8.92 (2.93)	9.47 (2.49)	8.35 (3.24)	**<0.001***
627	One-hand stationary dribble (scale 0–6)	3.48 (1.97)	3.15 (1.88)	3.83 (2.00)	**<0.001***
627	Overhand throw (scale 0–8)	4.83 (2.25)	4.05 (2.03)	5.65 (2.18)	**<0.001***
627	OCS total (0–14)	8.31 (3.27)	7.19 (2.82)	9.48 (3.30)	**<0.001***
627	FMS total (0–28)	17.23 (5.00)	16.67 (4.35)	17.83 (5.54)	**0.001***
627	Jumping sideways	51.23 (13.74)	50.77 (13.07)	51.71 (14.41)	0.523

Abbreviations: T1: timeline 1 (early childhood); T2: timeline 2 (middle childhood); LMS: locomotor skill; OCS: object control skill; FMS: fundamental movement skill. * = $p < 0.05$. P-values between genders have been measured by the Mann-Whitney U-test.

in OCS and FMS scores (T2, $p < 0.001$) in comparison to girls, whereas girls demonstrated higher scores in LMS compared to boys (T2, $p < 0.001$). (See Table 1.)

The results of the linear regression models are shown in Tables 2 and 3. Table 2 highlights that JS skills at T2 were significantly predicted by organised sports participation, particularly multisport participation ($p < 0.001$). Involvement in organised sports was also a significant predictor of LMS ($p < 0.001$), OCS ($p = 0.003$) and FMS ($p < 0.001$) in all participants, but children who participated in just one sport did not demonstrate greater LMS scores compared to non-participants ($p = 0.209$) (Table 3). Since gender was a significant predictor in models 2–4, the results of all models were also analysed according to gender. In girls, participation in one sport predicted higher performance in JS ($p = 0.025$) and OCS ($p = 0.026$) scores, but no statistically significant differences were observed in boys ($p = 0.100$ to $p = 0.372$). The total variance explained in all participants was 23.5% (Model 1), 16.4% (Model 2), 20.8% (Model 3) and 16.8% (Model 4). (See Tables 2 and 3.) In practice, the difference in JS score was around 5 points (10.1%) between children who participated in two or more sports and their non-participating peers. Regarding LMS, OCS and FMS scores, the differences ranged from 1 to 2 points (equivalent to 12.1% to 14.5%) between non-participating and multisport participating children.

During the study, the amount of time spent outdoors emerged as a significant predictor of OCS and FMS. Specifically, an outdoor time ranging from 30 to 60 minutes per day better predicted OCS ($p = 0.004$) and FMS ($p = 0.019$). In practice, this means the difference between children who spent less than 30 min/d outdoors and those who spent 30–60 min/d outdoor time at OCS (10.5%) and FMS (6.4%) Interestingly, gender-based analyses unveiled a notable distinction among girls, outdoor time predicted higher JS ($p = 0.009$, 8.4%), OCS ($p = 0.006$, 14.5%) and FMS ($p = 0.003$, 10.0%) scores. However, such predictions were not observed among boys.

Interactions between time spent outdoors and organised sports participation on JS, LMS, OCS and FMS are presented in Table 4, and the confidence intervals in Table 5. Our analysis revealed no significant interaction effects between sports participation and time spent outdoors. Statistically significant interactions were observed for neither girls (JS [$p = 0.495$], LMS [$p = 0.407$], OCS [$p = 0.865$], FMS [$p = 0.667$]) nor boys (JS [$p = 0.592$], LMS [$p = 0.292$], OCS [$p = 0.644$], FMS [$p = 0.337$]).

Discussion

This study focused on longitudinally examining whether and how organised and non-organised PA participation in early childhood (3–8 years old) predicted MC in middle childhood (6–11 years). Our findings indicate that participation in organised sports was a predictor of MC, including JS, LMS, OCS and FMS. More specifically, multisport participation predicted a higher level of MC. Regarding non-organised PA participations, operationalised as outdoor time, we found predictability for JS, OCS, and FMS in girls. In boys, MC was not predicted by

Table 2. Predictability of jumping sideways between outdoor time and sport participation.

	Model 1 JS at T2		
Variables at T1	Unstandardised B	Std. Error	*p*-value
ALL			
Constant	19.762	2.929	
Outdoor time during the week			
Less than 30 min/d	ref.		
30–60 min/d	1.957	1.235	0.113
More than 60 min/d	1.104	1.743	0.527
Outdoor time on weekend			
Less than 60 min/d	ref.		
1–2 h/d	−1.885	1.668	0.259
More than 2 h/d	−0.095	1.817	0.958
Organised sports			
No participation	ref.		
One sport	3.029	1.092	**0.006***
Multisport	5.187	1.405	**<0.001***
Gender	0.640	0.984	0.516
Age	5.209	0.468	**<0.001***
R^2		23.5	
GIRLS			
Constant	22.837	3.677	
Outdoor time during the week			
Less than 30 min/d	ref.		
30–60 min/d	4.287	1.622	**0.009***
More than 60 min/d	5.473	2.419	**0.024***
Outdoor time on weekend			
Less than 60 min/d	ref.		
1–2 h/d	−3.627	2.030	0.075
More than 2 h/d	−0.927	2.280	0.685
Organised sports			
No participation	ref.		
One sport	3.291	1.462	**0.025***
Multisport	4.653	1.853	**0.013***
Age	4.504	0.607	**<0.001***
R^2		23.2	
BOYS			
Constant	15.559	4.937	
Outdoor time during the week			
Less than 30 min/d	ref.		
30–60 min/d	−1.422	1.893	0.453
More than 60 min/d	−3.872	2.560	0.132
Outdoor time on weekend			
Less than 60 min/d	ref.		
1–2 h/d	0.446	2.881	0.877
More than 2 h/d	1.597	3.066	0.603
Organised sports			
No participation	ref.		
One sport	2.710	1.643	0.100
Multisport	6.057	2.127	**0.005***
Age	6.267	0.730	**<0.001***
R^2		26.7	

Abbreviations: T1: timeline 1 (early childhood); T2: timeline 2 (middle childhood); JS: jumping sideways.
* = $p < 0.05$.

outdoor time. Moreover, we did not observe any interaction effects between organised and non-organised PA participation concerning MC.

Early childhood is widely recognised as the optimal period for promoting children's diverse FMS (Brian et al., 2020). This study addresses the potential of both organised and non-organised PA during early childhood in shaping MC later in life. Particularly noteworthy is the predictive value of organised sports participation on MC development, with children engaged in organised sports demonstrating enhanced skills at school age. Furthermore, compared to non-participating children, those participating in just one sport predicted higher performance in JS, OCS and FMS but did not predict higher performance in LMS. This finding may be attributed to the fact that basic LMS develop at an earlier stage than OCS skills (Goodway et al., 2019); thus, LMS do not differentiate as easily. Also, even children who rarely participated in organised sports exhibited sufficiently developed LMS levels. However, LMS also differed significantly for the non-participating children compared to the multisport participation group of children. The diversity of sports participation allows for greater movement variety, potentially leading to enhanced MC. On the other hand, several of the ECEC children participated in sports that were organised in different seasons. While these children did not necessarily engage in multiple sports at the same time, they still exhibited better skills resulting from their participation in more diverse sports. In other words, different basic MC skills are

Table 3. Predictability of MC (locomotor skills, object control skills, and fundamental movement skills) between organised and non-organised pa.

	Model 2 LMS at T2			Model 3 OCS at T2			Model 4 FMS at T2		
Variables at T1	Unstandardised B	Std. Error	*p*-value	Unstandardised B	Std. Error	*p*-value	Unstandardised B	Std. Error	*p*-value
ALL									
Constant	4.788	0.653		2.971	0.709		7.759	1.110	
Outdoor time during the week									
Less than 30 min/d	ref.			ref.			ref.		
30–60 min/d	0.228	0.275	0.407	0.876	0.299	**0.004***	1.104	0.468	**0.019***
More than 60 min/d	0.246	0.389	0.527	0.751	0.422	0.076	0.997	0.661	0.132
Outdoor time on weekend									
Less than 60 min/d	ref.			ref.			ref.		
1–2 h/d	0.041	0.372	0.912	−0.228	0.404	0.572	−0,187	0.632	0.768
More than 2 h/d	0.099	0.405	0.807	−0.263	0.440	0.550	−0.164	0.689	0.812
Organised sports									
No participation	ref.			ref.			ref.		
One sport	0.307	0.244	0.209	0.627	0.264	**0.018***	0.934	0.414	**0.024***
Multisport	1.290	0.313	**<0.001***	1.008	0.340	**0.003***	2.298	0.533	**<0.001***
Gender	−1.179	0.219	**<0.001***	2.235	0.238	**<0.001***	1.056	0.373	**0.005***
Age	0.749	0.104	**<0.001***	0.619	0.113	**<0.001***	1.369	0.177	**<0.001***
R^2		16.4			20.8			16.8	
GIRLS									
Constant	5.445	0.749		3.057	0.855		8.502	1.280	
Outdoor time during the week									
Less than 30 min/d	ref.			ref.			ref.		
30–60 min/d	0.628	0.331	0.058	1.044	0.377	**0.006***	1.672	0.564	**0.003***
More than 60 min/d	0.275	0.493	0.577	0.954	0.562	0.091	1.229	0.842	0.145
Outdoor time on weekend									
Less than 60 min/d	ref.			ref.			ref.		
1–2 h/d	0.247	0.414	0.550	0.032	0.472	0.945	0.280	0.706	0.692
More than 2 h/d	0.470	0.465	0.312	0.033	0.530	0.951	0.503	0.793	0.527
Organised sports									
No participation	ref.			ref.			ref.		
One sport	0.170	0.298	0.568	0.760	0.340	**0.026***	0.930	0.509	0.068
Multisport	0.882	0.378	**0.020***	0.962	0.431	**0.026***	1.843	0.645	**0.005***
Age	0.567	0.124	**<0.001***	0.530	0.141	**<0.001***	1.097	0.211	**<0.001***
R^2		12.1			10.5			16.1	
BOYS									
Constant	3.185	1.182		5.373	1.254		8.557	2.010	
Outdoor time during the week									
Less than 30 min/d	ref.			ref.			ref.		
30–60 min/d	−0,435	0.453	0.338	0.591	0.481	0.220	0.156	0.771	0.840
More than 60 min/d	−0.160	0.613	0.794	0.469	0.650	0.471	0.309	1.042	0.767
Outdoor time on weekend									
Less than 60 min/d	ref.			ref.			ref.		
1–2 h/d	−0.307	0.690	0.657	−0.737	0.732	0.315	−1.043	1.173	0.374
More than 2 h/d	−0.348	0.734	0.636	−0.796	0.778	0.307	−1.144	1.248	0.360
Organised sports									
No participation	ref.			ref.			ref.		
One sport	0.352	0.393	0.372	0.462	0.417	0.269	0.814	0.669	0.225
Multisport	1.669	0.509	**0.001***	1.046	0.540	0.054	2.816	0.866	**0.002***
Age	0.961	0.175	**<0.001***	0.725	0.185	**<0.001***	1.686	0.297	**<0.001***
R^2		16.7			10.0			17.7	

Abbreviations: T1: timeline 1 (early childhood); T2: timeline 2 (middle childhood); LMS: locomotor skill; OCS: object control skill; FMS: fundamental movement skill; ref: reference. * = $p < 0.05$.

performed and practised in different sports, so a diverse sports background can be more beneficial for the development of MC.

This study's findings revealed that spending 30–60 minutes or more outdoors following the ECEC predicted improvement in JS, OCS, and FMS for girls but not for boys atT2. Moreover, Kwon and her colleagues (Kwon et al., 2022) similarly observed that each additional 10 minutes spent outdoors predicted a 0.1 point increase in OCS standard scores, although the magnitude of improvement remained relatively modest. In our study, OCS scores improved by 1.0 point (14.5%) when comparing girls who spent less than 30 min/d outdoors to girls who spent 30–60 min/d outdoors. Conversely, neither our study nor the study by Kwon and her colleagues (Kwon et al., 2022) found a significant predictor between outdoor time and LMS.

The gender differences between boys and girls can be attributed to statistical variations in MC scores, where girls tend to achieve higher scores in LMS, while boys typically excel in OCS and FMS, as supported by previous studies (Bolger et al., 2021; Field & Temple, 2017; Iivonen & Sääkslahti, 2014; True et al., 2017; Zhao et al., 2023). Moreover, boys spent more time outdoors during the week compared to girls. Other studies have also found that boys get more moderate-to-vigorous PA than girls (Kulmala et al., 2024). Plausibly, boys may have benefited from longer durations of outdoor activities, thereby potentially enhancing their MC to a greater extent compared to girls. As a result, no significant differences were found in the regression models between boys' amount of outdoor time and MC.

Table 4. The interactions of MC with outdoor time and sports participation.

	Organised sports * outdoor time				Correct model			
Interaction	df	F	*p*-value	η_p^2	df	F	*p*-value	R^2
Organised sports * outdoor time (week)								
JS	4	0.787	0.534	0.005	8	6.462	**<0.001***	0.077
LMS	4	0.949	0.435	0.006	8	5.393	**<0.001***	0.065
OCS	4	0.200	0.939	0.001	8	3.3887	**<0.001***	0.048
FMS	4	0.675	0.609	0.004	8	6.390	**<0.001***	0.076
Organised sport * outdoor time (weekend)								
JS	4	1.214	0.303	0.008	8	6.155	**<0.001***	0.074
LMS	4	0.562	0.690	0.004	8	5.027	**<0.001***	0.061
OCS	4	1.834	0.121	0.012	8	2.765	**0.005***	0.035
FMS	4	1.765	0.134	0.011	8	5.414	**<0.001***	0.065

Abbreviations: JS: jumping sideways; LMS: locomotor skill; OCS: object control skill; FMS: fundamental movement skill. * = $p < 0.05$.

Table 5. Average variation of motor competence according to outdoor time and organised sport participation, examined by subgroups.

Organised sport	Outdoor time (min/day)	JS (mean)	JS 95% CI	LMS (mean)	LMS 95% CI	OCS (mean)	OCS 95% CI	FMS (mean)	FMS 95% CI	n
No participation	>30	45.24	42.14–48.34	8.11	7.45–8.78	6.94	6.20–7.69	15.06	13.93–16.18	71
	30–60	48.91	46.88–50.94	8.47	8.03–8.90	8.16	7.67–8.65	16.62	15.89–17.36	165
	<60	48.23	44.05–52.41	8.08	7.18–8.97	8.13	7.12–9.14	16.21	14.69–17.73	39
One sport	>30	50.91	47.62–54.19	8.44	7.74–9.15	7.54	6.75–8.33	15.98	14.79–17.18	63
	30–60	52.20	49.93–54.47	9.03	8.54–9.52	8.77	8.22–9.32	17.80	16.98–18.63	132
	<60	55.55	51.61–59.48	9.57	8.72–10.41	9.05	8.10–10.00	18.61	17.18–20.05	44
Multisport	>30	51.78	46.76–56.80	10.52	9.44–11.60	8.37	7.16–9.58	18.90	17.06–2.72	27
	30–60	58.22	55.04–61.41	10.10	9.42–10.79	9.13	8.36–9.91	19.24	18.08–20.40	67
	<60	58.84	52.86–64.83	10.47	9.19–11.76	9.90	8.45–11.34	20.37	18.19–22.55	19

Abbreviations: JS: jumping sideways; LMS: locomotor skill; OCS: object control skill; FMS: fundamental movement skill.

Interactions were examined to determine the predictability of organised sports and outdoor recreation time on MC, which provides valuable insights into the development of MC. Our results highlight that the interaction effect between MC and the combination of organised sports and outdoor time was not observed. For example, a physically active lifestyle develops already in childhood and extends into adulthood (Lounassalo et al., 2019; Telama et al., 2014). Based on this, a physically active lifestyle may be presumed to include more outdoor time and participation in organised sports. Since these variables independently predicted higher performance in MC, their combined effect could also have been assumed to be significant. However, the individual distinctions between different children were so great that the combined effect of the variables did not lead to significant findings, which suggests that children may not need simultaneous organised and non-organised sports to enhance their MC. Since children in ECEC are young, the development of MC is not simultaneously linked to many different factors. Although outdoor time did not have a large effect on LMS, these associations have been observed in other studies (Barnett et al., 2019) and may not have become significant in our study. Therefore, children must be physically active outdoors for at least 30 minutes after the childcare day or participate in organised activities to develop MC. In the future, investigating these factors with children who are slightly older will be crucial to determine whether this interaction transforms with age.

Strengths and limitations

Only a few studies have investigated longitudinal predictability between organised and non-organised PA and MC from early childhood to middle childhood. Another strength of this study is the cluster-randomised research based on geographical location and residential density across one nation. Additionally, MC was measured using different MC tests, which we can separate into different parts (JS, LMS, OCS, FMS). However, a limitation of this study is that we did not have data for the whole TGMD-3 and KTK sections available due to time and resource restraints. This might provide a limited view of skill levels, despite the subtests being chosen are identified as among the best representing the locomotor and object control skill factors of TGMD-3 (Wagner et al., 2017). We also wanted to avoid placing extensive burden on the children and their families. Furthermore, the question querying the child's participation in organised sports is, to some extent, a limitation of the study that can influence the interpretation of the study findings. The questionnaire did not provide clear instructions regarding the timeframe for reporting sports participation. Consequently, some respondents may have only considered their children's current involvement in organised sports, while others may have reflected on their children's participation throughout the year. As a result, definitively ascertaining whether multisport participation occurred concurrently or intermittently throughout the year is challenging. This ambiguity introduces potential variability in the responses. For future studies, we suggest clearly specifying the timeframe that the participation considers. PA may be either overestimated or underestimated in questionnaires, which presents a limitation to the study.

Conclusions

Overall, this study highlights the important and independent roles of organised sports participation and spending time outdoors in promoting MC development among children. The results suggest that multisport participation predicts the MC of all participants, emphasising its importance. Furthermore, time spent outdoors predicts higher performance in JS, OCS, and FMS for girls but not for boys. While organised sports participation emerged as a strong predictor of MC, notably, interactions between variables did not have a significant effect in this study. This suggests that children may not necessarily require simultaneous participation in organised sports activities and outdoor activities to enhance their MC.

In the future, coaches must be trained in and made aware of the importance of MC and organised and non-organised sports participation in children's activities. Additionally, future research should delve deeper into the impact of organised and non-organised PA on children's health. Overall, the combination of sports participation and outdoor activities underscores the need for further exploration into the intricate interplay between these factors and their effects on children's motor development, such as the effect of these on slightly older children.

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