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CLINICAL & BASIC RESEARCH

Patterns of Movement Performance among Japanese Children and Effects of Parenting Practices

Latent class analysis

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abstract: ***Objectives:*** This study aimed to examine the long-term effects of parenting practice during preschool years on children's movement performance in primary school. ***Methods:*** This three-year longitudinal study included 225 children aged 3–6-years-old. Parents reported baseline parenting practice and evaluated children's movement performance three years later. Latent class analysis was used to explore latent classes of movement performance. A post hoc test was used to identify the characteristics of different patterns. Finally, adjusted multinomial logistic regression models were used to test the influence of parenting practice on identified patterns of movement performance. ***Results:*** Children in this study were grouped into three movement performance patterns, labelled as 'least difficulties' (n = 131, 58.2%), 'low back pain' (n = 68, 30.2%) and 'most difficulties' (n = 26, 11.6%). After controlling for age, gender, having siblings or not, family structure, standardised body mass index, sleep condition and dietary habits, the researchers found that if parents played games with children frequently, the children would have a 0.287 times lower probability of being in the 'low back pain' class (95% confidence interval [CI]: 0.105–0.783). In addition, if parents take children to meet peers of a similar age frequently, children would have a 0.339 times lower probability of being in 'most difficulties' class (95% CI: 0.139–0.825). ***Conclusion:*** Primary healthcare providers should pay careful attention to children with movement difficulties. The study provides longitudinal evidence to support the applicability of positive parenting practice in early childhood to prevent children's movement difficulties.

Keywords: Movement; Parenting; Latent Class Analysis; Child; Longitudinal Study; Japan.

Advances in Knowledge

- *The study originally used the person-centred method to explore three patterns of children's movement performance in the context of a Japanese community.*
- *This study confirmed the long-term effects of parenting practice during preschool years on children's movement performance when they enter primary school.*
- *It was indicated that playing games with other children frequently contributed to preventing participants from developing low back pain, while taking children to meet peers of a similar age helped in preventing their movement difficulties during school age.*

Application to patient care

- *Primary healthcare providers should pay special attention to children with movement difficulties. The study provides longitudinal evidence to support the applicability of positive parenting practice in early childhood to prevent children's movement difficulties.*

Movement performance is defined as the competence or skills related to motor coordination, muscle strength and balance, which are shown in self-care, sport and other daily activities.[1] School-aged children need to possess motor skills, coordination and body control in order to complete daily activities.[2] Movement difficulties in childhood may reduce a child's participation in daily activities and even impact their quality of life in adulthood.[3,4] Recently, the prevalence of movement difficulties has been rising worldwide.[5] In Oman (N = 97; mean age = 12.9 ± 1.6 years old), 55% of the total sample developed low grip strength and approximately 45% scored low in flexibility and sit-up tests.[6] National reports in Japan also show a decline in school-aged children's movement performance, particularly among boys, which is at a historically low level.[7] However, there is no gold standard for measuring children's movement performance in existing research.[8] Therefore, person-oriented cluster analysis might be a possible method to identify the characteristics of movement performance of children in a community.

Movement performance is determined by complex interactions between biological development and social

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environment.[9] Differences are always expected for the movement performance of children in terms of age, gender, body size and lifestyles.[10–13] Home-rearing environment is one of the most important social environments in which parenting practice affects children directly.[14] Parenting practice refers to the observable behaviours that parents use to socialise their children in daily activities.[15] A cross-sectional study demonstrated that maternal permissive parenting was gender-specifically associated with better physical activity (PA) performance in children experiencing authoritative parenting.[16] However, results were not consistent with the findings of Bradley *et al.*, which indicated that high parental monitoring was associated with poorer PA performance for boys experiencing late puberty but increased PA performance in boys experiencing early puberty using longitudinal data.[17] Furthermore, only 16 of the 30 quantitative studies in an integrative review showed significant positive associations between supportive parenting and children's physical performance.[18] The majority of studies to date have focused on the intensity and frequency of PA instead of using health conditions or function status as the outcomes. Limited studies have explored the relationships between parenting practice and movement performance.

To fill gaps in existing research, the present three-year longitudinal study examined the influence of specific parenting practices for preschool children on patterns of movement performance while being of school age. To avoid bias of variable-centred methods, the study aimed to investigate: (1) the patterns of children's movement performance based on person-oriented cluster analysis; and (2) the effects of daily parenting practice on children during the preschool period. The researchers hypothesised that: (1) patterns of children's movement performance could be identified using different characteristics in a typical community; and (2) more positive stimulations in parenting contribute to preventing children from developing movement difficulties.

Methods

The present three-year longitudinal research study was part of a cohort study named "Community Empowerment and Care for well-being and healthy longevity" (CEC), involving all residents in T village, a typical suburban community of Japan with a population of almost 5,000 since 1991.[19] The inclusion criteria were as follows: (1) being aged 3–6-years-old; (2) living in T village; and (3) having at least one parent living together. The exclusion criteria were as follows: (1) having a disability, serious disease, or developmental delay; and (2) not living in T village for the next three years. In the baseline survey, 289 parents with children aged 3–6 years provided the information on demographics and parenting practice. After three years, children's movement performance was evaluated by parents. As 27 families dropped out of the project and 37 were excluded due to incomplete evaluation of movement performance, the final sample size was 225. All research procedures were reviewed and approved by the institutional review board and ethics committee of University of Tsukuba (Approved Number 1331). All participants provided written consent before participation.

Parenting practice was measured using the Index of Child Care Environment (ICCE), which has been used in Japanese child cohort studies for over 20 years.[20,21] ICCE is a Japanese questionnaire edition of the globally-used scale called the Home Observation for Measurement of the Environment (HOME) and shows high reliability ($\alpha = 0.891$).[22]

The ICCE is a self-reported questionnaire for parents; it consists of 13 items regarding parenting practice which are used independently in the present study. Questions for the 13 parenting practices are as follows: (1) How often do you play games with your child?; (2) How often do you go shopping with your child?; (3) How often do you read to your child?; (4) How often do you sing songs with your child?; (5) How often do you go to the park with your child?; (6) How often do you and your child meet with friends or relatives with children of a similar age?; (7) How often do you talk with your spouse about child care?; (8) How often does your spouse or any other caregiver help you with the child?; (9) How often do you and your spouse eat meals together with the child?; (10) What do you do if your child spills milk on purpose?; (11) How many times did you spank your child last week?; (12) Do you have anyone else that helps you with daily home-rearing?; and (13) Do you have anyone to consult with about child care?

Items 1–9 were measured using five-point Likert scale (1 = rarely, 2 = 1–3 times per month, 3 = 1–2 times per week, 4 = 3–4 times per week, 5 = almost every day). As the responses were not normally distributed, binary-category classification was used in the analysis based on ICCE manual (Unfavourable group = the bottom 25% of the total sample, favourable group = the rest). Item 10 had five options (1= hit the child, 2 = scold the child, 3 = discipline in another way, 4 = determine how to prevent it in the future, 5 = in other ways). Item 11 had five different options (1 = never, 2 = 1–2 times, 3 = 3–4 times, 4 = 5–6 times, 5 = almost every day). For items 10 and 11, responses were categorised into two groups (unfavourable = spank

children and favourable = no spank). For items 12 and 13, responses were originally measured in a binary manner (i.e. yes or no), in which the answer 'yes' was evaluated as favourable and 'no' was evaluated as unfavourable.

Movement performance of children in the present study was investigated using a nine-item parent-reported movement performance questionnaire, which has been used by community government in large scale population-based surveys of the general population in Japan for over 20 years.[23] Parents were required to compare their children's coordination with other children of the same age based on their daily observations after the community government explained evaluation points in detail. The nine items included the following: (1) Does your child always appear energetic before and after school? (Keep active); (2) Are there any difficulties your child faces in order to continue running? (Keep running); (3) Does your child have difficulties maintaining correct sitting posture? (Good sitting posture); (4) Does your child have any arm pain? (Arm strength); (5) Does your child have any lower low back pain? (Low back strength); (6) Does your child have any leg pain? (Leg strength); (7) Are there any difficulties for your child in moving agilely to avoid obstacles? (Agility); (8) Does your child have any difficulties balancing? (Balance); and (9) Does your child have any difficulties moving their body flexibly? (Flexibility). Participants could respond to each item with 'no' (without any difficulties) or 'yes' (having some difficulties).

Demographics as well as children's sleep condition and dietary habits were considered as covariates in the analysis models. Demographics included children's age, gender, body mass index (BMI; standardised BMI [BMI SDS] was used in the analysis), having siblings or not and family structure (e.g. nuclear family type and extended family type). Children's sleep condition was reported by parents as 'sufficient' or 'not sufficient'. Dietary habits were also reported by parents as 'no fussy eating' or 'having fussy eating behaviours'.

First, descriptive statistics were used to confirm demographics, baseline condition of parenting practice and follow-up year's movement performance. Second, latent class analysis (LCA) was used to explore patterns of movement performance.[24] Third, a post hoc test for the Chi-squared test (Bonferroni) and analysis of variance (ANOVA; LSD and S-N-K) was used to clarify differences in demographics among the patterns of movement performance and to identify the characteristics of the patterns. Finally, adjusted multinominal logistic regression analysis was applied to confirm the associations between parenting practice and movement performance patterns.

All statistical analyses were performed using the statistical package for the social sciences (SPSS), version 26.0 (IBM Corporation, Armonk, New York, USA) and Mplus, version 8.0 (Muthén and Muthén, Los Angeles, California, USA).

Results

A total of 225 children (mean age = 4.13 ± 0.87 years; mean BMI SDS = 0.12 ± 0.98) were evenly distributed in gender and family structure—boys (n = 119, 52.9%), girls (n = 106, 47.1%), nuclear family (n = 107, 47.6%) and extended family (n = 118, 52.4%)—while 83.6% of children (n = 188) had siblings. A total of 85.8% of children (n = 193) had sufficient sleep, while 68.9% of children (n = 155) had fussy eating behaviours [Table 1].

In baseline year, the item with most negative evaluations was 'How many times did you spank your child last week?', in which 37.8% of parents (n = 85) reported they had spanked their child in the last week. The item with least negative evaluations was 'Do you have anyone else help you in daily home-rearing?', in which only 2.2% of parents (n = 5) reported they took care of children without any help from others [Table 2]. As for the movement performance of children three years later, the present study showed that more than

Table 1: Demographic background in the baseline year of the children included in this study (N = 225)

Variable	n (%)
Mean age of child in years ± SD	4.13 ± 0.87
Gender of child	
Boy	119 (52.9)
Girl	106 (47.1)
Siblings	
Only child	37 (16.4)
Having siblings	188 (83.6)
Family structure	
Nuclear family	107 (47.6)
Extended family	118 (52.4)
BMI SDS of child	0.12 ± 0.98*
Sleep condition of child	
Sufficient	193 (85.8)
Not sufficient	32 (14.2)
Fussy eating behaviour of child	
No	70 (31.1)
Yes	155 (68.9)

SD = standard deviation; BMI SDS = standardised body mass index

Table 2: Parenting practice in baseline year and movement performance of children three years' later (N = 225)

Parenting practice	n (%)
Play games with child	
Few	44 (19.6)
Frequently	181 (80.4)
Shopping with child	
Few	21 (9.3)
Frequently	204 (90.7)
Read books to child	
Few	56 (24.9)
Frequently	169 (75.1)
Sing songs with child	
Few	45 (20.0)
Frequently	179 (79.6)
NA	1 (0.4)
Take child to play outside	
Few	27 (12.0)
Frequently	197 (87.6)
NA	1 (0.4)
Take child to meet peers of similar age	
Few	46 (20.5)
Frequently	178 (79.1)
NA	1 (0.4)
Eat meals together with child	
Few	48 (21.4)
Frequently	176 (78.2)
NA	1 (0.4)
Spank child for mistakes	
Spank	14 (6.3)
Not spank	210 (93.3)
NA	1 (0.4)
Spank child last week	
Spank	85 (37.8)
Not spank	138 (61.3)
NA	2 (0.9)
Take care of child with others	
Few	18 (8.0)
Frequently	204 (90.7)
NA	3 (1.3)
Have helpers	
No	5 (2.2)
Yes	218 (96.9)
NA	2 (0.9)
Have someone to consult with	
No	7 (3.1)
Yes	216 (96.0)
NA	2 (0.9)
Movement performance	
Keep active	
With difficulties	69 (30.7)
Without difficulties	156 (69.3)
Keep running	
With difficulties	62 (27.6)
Without difficulties	163 (72.4)
Good sitting posture	
With difficulties	139 (61.8)
Without difficulties	86 (38.2)
Arm strength	
With difficulties	127 (56.4)
Without difficulties	98 (43.6)
Low back strength	
With difficulties	59 (26.2)
Without difficulties	166 (73.8)
Leg strength	
With difficulties	54 (24.0)
Without difficulties	171 (76.0)
Agility	
With difficulties	114 (50.7)
Without difficulties	111 (49.3)
Balanced	
With difficulties	94 (41.8)
Without difficulties	131 (58.2)
Flexibility	
With difficulties	163 (72.4)
Without difficulties	62 (27.6)

NA = no answer.

half of the children were reported to have some difficulties on: (1) maintaining right sitting posture (n = 139, 61.8%); (2) arm strength (n = 127, 56.4%); (3) agility (n = 114, 50.7%); and (4) flexibility (n = 163, 72.4%).

Table 3 shows the model fit information for five LCA models with 2–6 latent classes. Akaike information criterion (AIC), Bayesian information criterion (BIC) and sample-adjusted Bayesian information criterion (aBIC) in the three-class model decreased more sharply than in the two-class model and the decline scope was the biggest among all the models (ΔAIC = -71.126, ΔBIC = -36.965, ΔaBIC = -68.657). Entropy in the three-class model was the highest among all the models (0.935). The smallest sample size of the latent class is just over 25 (n = 26) and the three-class model was significantly better than two-class model (P <0.01). Based on model selection recommendations for LCA model, the three-class model was considered as the best identified class.

Table 3: Model fit information for the latent class analysis models

	Log-likelihood	df	G-squared	AIC	BIC	aBIC	Entropy	BLRT
Two-class model	−1112.676	492	381.606	2263.352	2328.258	2268.043	0.827	<0.01
Three-class model	−1067.113	481	278.509	2192.226	2291.293	2199.386	0.935	<0.01
Four-class model	−1036.648	471	217.222	2151.296	2284.524	2160.925	0.903	<0.01
Five-class model	−1018.885	462	194.023	2135.769	2303.158	2147.867	0.921	<0.01
Six-class model	−1009.066	452	174.386	2136.133	2337.683	2150.700	0.935	0.122

df = degrees of freedom; AIC = Akaike information criteria; BIC = Bayesian information criteria; aBIC = adjusted Bayesian information criterion; BLRT = bootstrapped likelihood ratio test.

Table 4 presents the results of the Chi-squared test and one-way ANOVA analysis, showing the demographics and movement performance characteristics of the three latent patterns. There was no significant difference between the demographics of the three movement performance patterns (P >0.1). All nine items, except flexibility, showed significant differences among three movement performance patterns (P <0.05). The results of post hoc test indicated that the number of responses of movement with difficulties in class 3 was significantly greater than that in class 1 among all the nine items, except flexibility (P <0.05). No significant difference was found between class 2 and class 1 in the following categories: keep active, keep running, arm strength, agility and flexibility. No significant difference was shown between class 2 and class 3 in the following categories: good sitting posture, arm strength, leg strength and balance (P >0.05). The number of responses indicating having low back pain in class 2 was significantly greater than that in class 1, but less than that in class 3 (P <0.05). Class 1 was labelled as having the least difficulties (LD), class 2 was labelled as having low back pain (LBP) and class 3 was labelled as having the most difficulties (MD).

The LD class contained 58.2% (n = 131) of the sample and had high probabilities of movement performance without difficulties. The LBP class contained 11.6% (n = 26) of the sample, and all samples showed low back pain in the group. The MD class contained 30.2% (n = 68) of the sample and had low probabilities of movement performance without difficulties [Figure 1].

Table 5 shows the associations between parenting practice and children's movement performance. In the multinomial logistic regression models, each parenting practice was considered as an independent variable respectively, while age, gender, having siblings or not, family structure, BMI SDS, sleep condition and dietary habits were included in the models as covariates. The LD class was used as the reference class to show the effect of positive parenting practice on preventing movement difficulties. Model 1 indicated that if parents played games with children frequently, the children would have a 0.287 times lower probability of being in the LBP class (95% confidence interval [CI]: 0.105–0.783). Model 2 indicated that if parents take their children to meet peers of a similar age frequently, the children would have a 0.339 times lower probability of being in the MD class (95% CI: 0.139–0.825).

Discussion

To the best of the authors' knowledge, this study is the first in Japan to examine the long-term effects of parenting practice in children's preschool period on their movement performance outcomes when they are of school-going age. The researchers originally explored three patterns of children's movement performance and identified their characteristics in a sample of children from a suburban area in central Japan. Based on the longitudinal results, the researchers indicated that more positive stimulations in parenting practice, such as frequently playing games with children frequently and taking children to meet peers of a similar age, contribute to preventing children from developing movement difficulties three years later.

Several studies have used the person-oriented method to explore patterns of movement performance; however, the results were inconsistent. Jaakkola *et al.* investigated PA, sedentary time, perceived competence, motor competence, cardiorespiratory fitness and muscular fitness in a Finnish elementary school student sample (N = 491, mean age = 11.27 ± 0.32 years) and labelled three movement profiles as 'at-risk' (37.7%, n = 185), 'intermediate' (49.3%, n = 242) and 'desirable' (13.0%, n = 64).[25] Four movement profiles—which were 'poor movers' (27.9%, n = 129), 'average movers' (38.4%, n = 177), 'skilled movers' (18.9%, n = 87) and 'expert movers' (14.8%, n = 68)—were identified when focusing on the performance of leap, throw-catch, jump, push-up, sit-up tests.[26] The

Table 4: Demographics and movement performance characteristics of three patterns

Variable	Movement performance, n (%)			F/χ^2	*P* value
	Class 1	Class 2	Class 3		
Age in years ± SD		4.13 ± 0.87		2.112	0.123
Gender					
Boy	65 (54.6)	14 (11.8)	40 (33.6)	1.533	0.465
Girl	66 (62.3)	12 (11.3)	28 (26.4)		
Siblings					
Single child	23 (62.2)	4 (10.8)	10 (27.0)	0.289	0.865
Having siblings	108 (57.4)	22 (11.7)	58 (30.9)		
Family structure					
Nuclear family	61 (57.0)	11 (10.3)	35 (32.7)	0.757	0.685
Extended family	70 (59.3)	15 (12.7)	33 (28.0)		
BMISDS ± SD		0.12 ± 0.98		0.389	0.678
Sleep					
Sufficient	19 (59.4)	3 (9.4)	10 (31.3)	0.175	0.916
Not sufficient	112 (58.0)	23 (11.9)	58 (30.1)		
Fussy eating					
No	93 (60.0)	17 (11.0)	45 (29.0)	0.653	0.721
Yes	38 (54.3)	9 (12.9)	23 (32.9)		
Keep active					
With difficulties	21_a (30.4)	5_a (7.2)	43_b (62.3)	48.721	<0.001
Without difficulties	110 (70.5)	21 (13.5)	25 (16.0)		
Keep running					
With difficulties	15_a (24.2)	4_a (6.5)	43_b (69.4)	62.315	<0.001
Without difficulties	116 (71.2)	22 (13.5)	25 (15.3)		
Good sitting posture					
With difficulties	66_a (47.5)	20_b (14.4)	53_b (38.1)	17.254	<0.001
Without difficulties	65 (75.6)	6 (7.0)	15 (17.4)		
Arm strength					
With difficulties	59_a (46.5)	$16_{a,b}$ (12.6)	52_b (40.9)	18.300	<0.001
Without difficulties	72 (73.5)	10 (10.2)	16 (16.3)		
Low back strength					
With difficulties	12_a (20.3)	20_b (33.9)	27_c (45.8)	60.649	<0.001
Without difficulties	119 (71.7)	6 (3.6)	41 (24.7)		
Leg strength					
With difficulties	15_a (27.8)	14_b (25.9)	25_b (46.3)	30.083	<0.001
Without difficulties	116 (67.8)	12 (7.0)	43 (25.1)		
Agility					
With difficulties	47_a (41.2)	$15_{a,b}$ (13.2)	52_b (45.6)	30.090	<0.001
Without difficulties	84 (75.7)	11 (9.9)	16 (14.4)		
Balanced					
With difficulties	42_a (44.7)	16_b (17.0)	36_b (38.3)	12.743	0.002
Without difficulties	89 (67.9)	10 (7.6)	32 (24.4)		
Flexibility					
With difficulties	95_a (58.3)	18_a (11.0)	50_a (30.7)	0.175	0.916
Without difficulties	36 (58.1)	8 (12.9)	18 (29.0)		

SD = standard deviation.

a,b, c refer to different groups based on the results of the post hoc test using Bonferroni method.

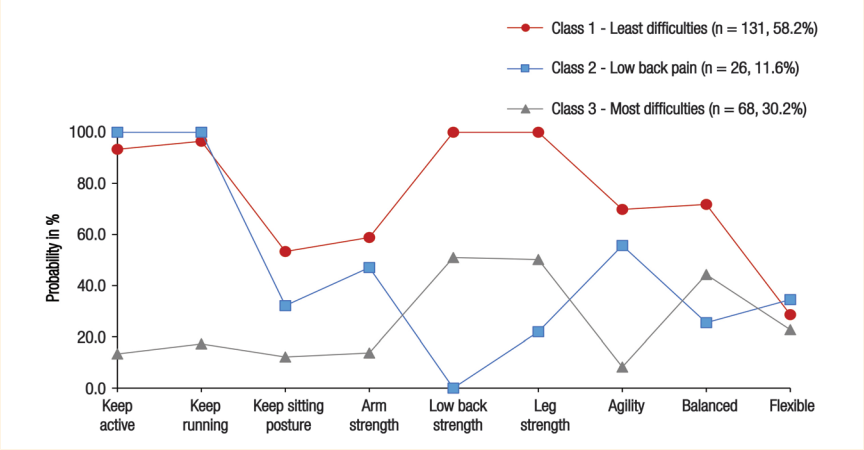

Figure 1: Item probability of movement performance without difficulties in three classes.

present study explored three patterns of children's movement performance and originally identified the characteristics associated with different types of movement difficulties. The biggest cluster, LD (n = 131, 58.2%), received significantly higher probability of 'no difficulties' than the MD cluster (n = 68, 30.2%) for all nine items except flexibility. All samples in the LBP cluster (n = 26, 11.6%) reported having pain in their low back, which was significantly different from the other two clusters. Previous studies highlighted the prevalence of low back pain in school-aged children, which was 24% in a British sample (N = 1,376), 22% in an American sample (N = 1,241) and 51% in a Danish sample (N = 1,395). This suggests low back pain is an important and relatively common problem in school children.[27] The present study's results are consistent with the existing research and additionally suggest that low back pains should also be given attention in Japan.

Table 5: Significant results of multinominal logistic regression model showing associations between parenting practice and movement performance

Variable	LBP versus LD class		MD versus LD class	
	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Model 1				
Play games with child	0.287 (0.105–0.783)	0.015	0.834 (0.371–1.873)	0.660
Age	0.860 (0.499–1.480)	0.585	1.389 (0.965–1.998)	0.077
Gender	1.101 (0.453–2.674)	0.833	1.491 (0.804–2.764)	0.205
Having siblings or not	0.543 (0.141–2.092)	0.375	0.847 (0.362–1.984)	0.702
Family structure	0.773 (0.315–1.901)	0.575	1.166 (0.634–2.147)	0.621
BMI SDS	0.997 (0.616–1.612)	0.989	0.957 (0.695–1.316)	0.785
Sleep condition	0.961 (0.245–3.777)	0.955	1.144 (0.475–2.759)	0.764
Fussy eating	0.914 (0.349–2.393)	0.855	0.843 (0.436–1.631)	0.613
Model 2				
Take child to meet peers of a similar age	1.175 (0.443–3.115)	0.746	0.339 (0.139–0.825)	0.017
Age	0.936 (0.552–1.586)	0.806	1.401 (0.973–2.019)	0.070
Gender	1.006 (0.419–2.413)	0.990	1.399 (0.745–2.627)	0.296
Having siblings or not	0.634 (0.169–2.378)	0.499	0.837 (0.357–1.964)	0.682
Family structure	0.880 (0.367–2.110)	0.774	1.155 (0.626–2.134)	0.645
BMI SDS	1.085 (0.681–1.728)	0.732	0.941 (0.685–1.294)	0.710
Sleep condition	0.853 (0.220–3.300)	0.818	1.117 (0.459–2.718)	0.807
Fussy eating	0.921 (0.356–2.385)	0.865	0.878 (0.450–1.712)	0.703

LBP = low back pain; LD = least difficulties; MD = most difficulties; OR = odds ratio; CI = confidence interval.

Reference group: play games with child = few; encourage child to play with peers of a similar age = few; gender = boy; having siblings or not = only child; family structure = nuclear family; sleep = sufficient; fussy eating = no fussy eating behaviours; age and BMI SDS = continuous variables.

Many previous studies have indicated that parent-related factors, such as parents' attitude towards children's PA, parents' exercise habits and parenting practice, are associated with children's daily physical activities and, therefore, influence children's motor competence and physical performance.[28] A systematic review indicated supporting children to do PA or enrol in PA classes as doing PA together significantly contributed to improving children's physical performance.[29] Davison originally created the Activity Support Scale (ACTS) to measure parental support for children's PA and confirmed that providing children with the chance or places to be active as well as playing sports with them is beneficial for children to improve their physical activity levels.[30] In addition, previous studies also highlighted the important role of peer interactions on children's motor performance.[31] One systematic review reported a positive influence of peers' support on PA and health outcomes.[32] The present study's results are consistent with previous studies and further clarified long-term effects of parenting practice during preschool years on children's movement performance on entering primary school. The researchers indicated that playing games with preschool children frequently contributes to preventing them from developing back pain three years later, while taking children to meet peers of a similar age is beneficial to the prevention of children's movement difficulties when reaching school-going age.

On the other hand, children's age, gender, BMI, sleep condition and dietary habits were not significantly associated with children's movement performance in the current study, which are not consistent with existing research. Boys performed better in 'walking', while girls performed better in 'ball control', and no gender difference were observed in 'running' and 'kicking' in a meta-analysis for Japanese preschool children.[33] Cardio-respiratory fitness and flexibility decreased with increasing age in a sample of 4,903 European children aged 6–11 years.[34] Sleep duration did not have a consistent significant effect on physical fitness, while fruit and vegetable intake positively related to physical performance with small effects.[35] Inconsistent results suggested influence factors and that their effects of movement performance are complex and different across cultures.

Several limitations should be considered when interpreting the present study's results and designing future studies. First, children's movement performance was only measured by parent-reported questionnaires in the present study. Objective tests should be performed to verify the consistency of the results in the future. Second, although the researchers controlled several covariates, more related factors, such as SES and baseline movement performance, should also be included in the final analysis model. Finally, the sample size was small because of the loss to follow-up.

Conclusion

Children in this study were grouped into three movement performance patterns labelled LD, LBP and MD, based on a person-oriented perspective and cluster analysis. The LD group was characterised as having the highest probability of having no difficulties for all items, while the MD group was characterised as having the lowest probability of having no difficulties. The LBP group was characterised by having all samples in the group develop low back pain. More positive stimulations in parenting practice during preschool years, such as frequently playing games with children and taking them to meet peers of a similar age contributed to preventing children's movement difficulties when they entered primary school. Children with movement difficulties should be carefully monitored by healthcare providers. Parents' support is beneficial for children to prevent developing movement difficulties. Nevertheless, there is still a great need for more diverse samples and sufficient sample sizes to confirm the results across cultures.

AUTHORS' CONTRIBUTION

ZZ and CK conceptualised the study. ZZ, DJ and TK designed the methodology. YZ and XL contributed with the software. ZZ, DJ, AA and MM contributed to the validation process. ZZ performed the formal analysis. DJ, XL, AA, MM, YS, SI and RO performed the investigation. TA provided the resources. DJ, YS, TW, EtT, EmT and TA contributed to the data curation. ZZ, CK, DJ and XL contributed to the drafting, review and editing of the manuscript. TA contributed to the visualisation, supervision of the work, project administration and funding acquisition. All authors have approved the final version of the manuscript.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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