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Motor Skills in Early Childhood: Exploring the Roles of Individual and Family Factor in Danish Preschools

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Abstract

Background

Research shows that children with well-developed motor skills tend to thrive more overall. This study analyzes the correlation between motor skills in children aged 3–6 and factors such as age, sex, socioeconomic status (SES), sports participation (children and parents), living arrangements, home language, and well-being to better understand determinants of motor development.

Methods

This cross-sectional study includes data from 390 children and 260 parents across four municipalities, collected between November 2023 and January 2024. Children's motor competencies were assessed using the MABC-2. Parents completed questionnaires on children’s participation in organized physical activities, motivation, enjoyment, ball-play competence, general and preschool well-being, family structure, home language, economic situation, and parental experience with leisure activities. Descriptive statistics were compiled per preschool, and associations between MABC-2 percentile scores and child characteristics, including well-being, were analyzed using linear regression adjusted for sex.

Conclusion

This study suggests that motor development is influenced by multiple factors. No clear link was found between well-being and motor competence in typically developing children, and SES showed limited significance. Participation in organized sports and a movement-oriented family culture appear to enhance ball skills. Children in shared custody arrangements performed less well in some areas.

Introduction

The background for this study is to investigate key factors that may influence motor development. These include age, sex, level of physical activity, socioeconomic status, and family circumstances (Jones et al., 2020; Iivonen & Sääkslahti, 2014; Barnett et al., 2016; Zheng et al., 2022).

Children with well-developed motor skills tend to be more physically active, perform better cognitively, and participate more in sports later in life compared to peers with lower motor competence (Barnett et al., 2009; Bornstein et al., 2013; McKenzie et al., 2002; Ridgway et al., 2009; Vandorpe et al., 2011; Lubans et al., 2010).

Early motor difficulties are associated with persistent challenges at school entry (Brixval et al., 2011; Pant & Pedersen, 2018) and may be linked to social withdrawal, mental health problems, and an increased risk of being overweight (Blank et al., 2019; Lingam et al., 2012; Pant et al., 2019).

These findings underscore the importance of early detection and the potential for timely intervention.

Individual-level correlations

According to Barnett et al. (2016), there is evidence that age positively correlates with motor competences, particularly object control, locomotor skills, and stability. Furthermore, research supports the existence of sex-based differences in motor skills among children aged 3 to 6 years. Boys typically outperform girls in ball-handling and object manipulation tasks, whereas girls tend to excel in balance, stability-demanding activities, and locomotor movements such as crawling, walking, running, skipping, and jumping (Iivonen & Sääkslahti, 2014; Zheng et al., 2022; Hardy et al., 2010). It remains unclear whether these sex differences are primarily driven by biological or environmental factors. McKenzie et al. (2002) suggest that boys may perform better in ball-related skills due to more frequent engagement in ball games, while girls may develop superior balance and jumping abilities through play activities that emphasize these movements.

Motor competence may also influence social and emotional development. In a study by Salaj and Masnjak (2022), 125 preschool children aged 5 to 6 years were examined to explore the relationship between motor competence and social-emotional difficulties. The main finding revealed a weak correlation, highlighting the need for further research to strengthen the evidence base in this area. However, in cases where children are diagnosed with Developmental Motor Coordination Disorder (DMCD), clearer associations have been found between motor difficulties and emotional or behavioral challenges, including anxiety and depression (Emck et al., 2009; Piek et al., 2008; Lee et al., 2020).

Physical activity appears to be positively associated with motor competence. Barnett et al. (2016) found a positive relationship between physical activity and overall motor coordination, although not with specific domains such as object control or locomotor skills. This is further supported by Adank et al. (2018) and Jones et al. (2020), who demonstrated that moderate to vigorous physical activity is positively linked to motor competence, with evidence suggesting that this relationship begins in early childhood.

In a 2024 study, Meklin et al. investigated the relationship between motor competence and children’s participation in sports clubs, assessing 259 children at age six and again three years later. Notably, participation in ball sports at age six predicted higher motor competence among girls, whereas no similar association was found for non-ball sports or among boys.

Family-level correlations

Although no direct relationship has been established between children's motor competence and parental participation in sports clubs, studies indicate that physically active parents positively influence children's motor skills and activity levels (Meklin et al., 2024; Rodrigues et al., 2018; Dellert & Johnson, 2014). Meklin et al. (2024) found this effect particularly among girls, while Rodrigues et al. (2018) emphasized stronger associations in same-sex parent–child pairs. Interventions involving both parents have also

demonstrated beneficial outcomes. A literature review by the Danish Health Authority identifies parents as key motivators and role models in promoting children's physical activity (Aggestrup, 2017). Xu et al. (2015) supports this view, highlighting parental behavior, self-efficacy, and supportive parenting styles as influential factors.

The relationship between motor development and socioeconomic position has been examined in several studies. A review by Golding et al. (2014) shows that although the identified studies measure socioeconomic position and motor development in different ways among children up to 14 years of age, all studies report a correlation between lower socioeconomic position and a higher degree of delayed motor development in children (Lingam et al., 2009; Golding et al., 2014). This correlation is supported by a report from the Children's Health Database, which found an increased proportion of motor challenges among children aged eight to ten months whose parents had completed only primary education (Pedersen et al., 2019). An English study further confirms this association, showing that children aged 7–8 years from lower socioeconomic backgrounds are at greater risk of developing motor developmental disorders (Lingam et al., 2009). However, these findings are contradicted by an Australian study by Veldman et al. (2018), which found no correlation between lower socioeconomic position among parents of children aged 11 to 24 months and delayed motor development. A Danish study based on the Danish National Birth Cohort also presents divergent findings. The study found that children of mothers with higher educational attainment were at increased risk of motor developmental disorders (Faebo Larsen et al., 2013).

An increasing number of children today reside in shared custody arrangements between mother and father. This development is partly due to changes in family structures, the emergence of new family forms, and parental separation. The prevalence of shared custody has primarily been documented among children from divorced families. In 2009, 16% of children in divorced families lived equally with both parents; by 2021, this proportion had increased to 41% (Ottosen et al., 2018, 2022). A similar trend has been observed in other countries (Fransson et al., 2018; Kitterød & Liden, 2021). This increase has occurred despite a slight decline in the overall divorce rate—from 54% in 2014 to 41.8% in 2021 (Statistics Denmark). Several studies have examined the scope and consequences of shared custody, particularly when it results from parental separation (He et al., 2024; Niemistö et al., 2024). Research generally indicates that divorce negatively affects children's well-being across multiple domains, including physical health, risk behavior, emotional adjustment, and overall well-being, with long-term adverse effects (Amato, 2005; Frimmel et al., 2024; Nielsen et al., 2025). Nielsen et al. (2025) demonstrated that divorce may lead to a series of negative outcomes persisting for up to 12 years following parental separation.

Children from minority backgrounds may also face barriers to motor development. Studies from the United Kingdom show that children of Pakistani and Bangladeshi descent score lower in fine motor and communication domains compared to their British peers, even after adjusting for socioeconomic factors (Kelly et al., 2006). However, comparable data from Denmark is currently lacking.

Previous research has primarily been conducted outside Denmark, and Danish studies remain limited. Therefore, the aim of this study is to analyze the relationship between motor skills in children aged 3–6 years and factors such as age, sex, socioeconomic status (SES), sports participation of both children and parents, residential arrangements, home language, and well-being. The objective is to gain a deeper understanding of potential determinants of children's motor development, as measured by the Movement Assessment Battery for Children, Second Edition (MABC2).

Methods

Study design and participants

This cross-sectional study is based on participants from a non-randomized wait-list control intervention titled Ball-based Play in Preschool (BPiP). Recruitment involved Danish municipalities collaborating with the National Olympic Committee and Sports Confederation of Denmark (DIF) through the Move for Life partnership (Bevæg dig for livet). Four municipalities agreed to participate, each contributing two preschools for a subsequent ball-play intervention.

Children enrolled in the eight preschools at baseline were eligible, pending parental consent. Recruitment occurred between November 20, 2023, and January 10, 2024. Children without consent could participate in test activities, but their results were not recorded.

Ethics and Data Management Procedures

The study was conducted according to the Helsinki declaration. Children and parents received information about the study, including its purpose, voluntary participation, and data handling. Informed consent was obtained from all participating parents. Motor skill assessments were conducted in a playful setting, with children unaware of their performance. They received encouragement and could opt out of any or all tests.

Data were handled confidentially, accessible only to the research team, and stored in accordance with Danish Data Protection Agency regulations. All participants remain anonymous in publications.

Following Danish law (LBK no. 1338 of 1/9/2020) and review by the Ethics Committee of Southern Denmark (case: 20232000-77), no formal ethical approval was required, as no biological material was collected. The study was approved by the Research and Innovation Organization (RIO) at the University of Southern Denmark (review no. 11.944).

Baseline motor assessments were conducted in January 2024, and parent questionnaires were collected from January to March 2024. Of 462 eligible children, 390 completed the MABC-2, and 260 had questionnaires submitted. Missing data were due to illness, lack of consent, or incomplete questionnaires.

Data measurements and analyses

Movement Assessment Battery for Children – 2 (MABC-2)

An extensive literature review informed the selection of the Movement Assessment Battery for Children – Second Edition (MABC-2), chosen for its age-appropriateness, theoretical foundation, validity, reliability, and practical applicability (Henderson, 2007). Only quantitative data from the test were used in the BPiP study.

Each test session lasted approximately 30 minutes and was conducted in the child's preschool. Test setups varied but allowed for 4–5 stations aligned with MABC-2 tasks. Children were tested individually within small peer groups, with efforts made to minimize distractions. Children could move freely between stations or be accompanied by the tester, depending on their comfort level. Preschool staff were occasionally present. Although the test recommends wearing sneakers, many children were tested barefoot due to lack of appropriate footwear.

Testers followed the MABC- 2 manual and used the accompanying test materials. The testers were either physiotherapists, physiotherapy students, or hold a Master's degree in sports science. Before testing, all testers underwent three hours of training, during which an experienced tester with MABC-2 explained the manual and the scoring process. This included watching videos where the testers scored the child and discussed their evaluations to achieve reliable scoring across testers. The children in BPiP were all tested in the "MABC-2 for age 3–6".

Tabel 1. Description of the Movement Assessment Battery for Children – 2 for age 3–6.

Movement Assessment Battery for Children – 2 (Henderson et al 2007)			
Manual Dexterity Much of what a young child learns is acquired through use of the hands			
Task	Posting coins	Threading beads	Drawing trail
Records	Number of seconds taken to complete each properly executed trial. Both hands are tested	Number of seconds taken to complete each properly executed trial	Numbers of errors. Without crossing a boundary
Background	Speed and sureness of movement by each hand	Coordination and speed of the two hands for the performance of a single operation	Hand-eye coordination and precision as it is required in the control of a writing implement
Aiming & catching (Ball Skills) The ability to catch hold of something we do as one falls is essential for survival, and something we do without conscious thought			
Task	Aiming & catching a beanbag	Throwing beanbag onto mat	
Records	Number of correctly executed catches out of 10 attempts	Number of successful hits out of 10 attempts	
Background	Accuracy of receiving a moving object projected either by the assessor or by the child	Accuracy of aiming at a target	
Balance Stabilizing the body is a prerequisite for adaptive control of movement.			
Task	One - leg balance	Walking heels raised on line	Jumping on mats
Records	Number of seconds, up to 30 the child maintains balance Both the right and left leg are tested	Number of correct consecutive steps taken from the beginning of the line without stepping off the line or letting the heels touch the floor	Number of correct consecutive jumps from the start without landing outside the boundary lines.
Background	Static balance in which the child is required to hold a specified position for as long as possible	Dynamic balance involving slow accurate movement	Dynamic balance involving fast, explosive movement

Raw scores from the MABC-2 are converted to age-based standard scores, yielding one total score and three sub-scores. For ages 3–4, scores are assigned in six-month intervals; for ages 5–16, scores are assigned by year. Standard scores are based on a mean of 10 and a standard deviation of 3, and are further converted to percentiles for comparison (Henderson, 2007). Percentile ranks range from 1 to 99, with scores between the 6th and 15th percentile considered “at risk,” and scores at or below the 5th percentile indicating significant motor difficulties (Henderson, 2007).

The MABC-2 demonstrates good reliability and validity, including interrater and test-retest reliability (Henderson, 2007; Griffiths et al., 2018). To maximize usable data, missing test items were replaced using scores from the opposite limb or averaged from other items within the same category when only one item was missing.

Parental questionnaire

The parent questionnaire was developed to gather background information and explore child-level outcomes. It included newly developed items and translated questions from previous studies, covering areas such as the child’s participation in organized physical activities, motivation, and ball-related play at home, as well as four items on motivation and enjoyment of physical activity (Cairney et al., 2018). Background questions addressed the child’s general and preschool well-being (1–5 scale), parental relation, shared residence, siblings, home language, economic situation, and family experience with organized activities.

The questionnaire was created for the BPiP study (Larsen et al. 2026) and pilot-tested with experts and parents, and revised based on feedback and cognitive interviews (Collins, 2003). Data were collected via SurveyXact using a link, QR code, and child ID. To increase response rates, researchers visited preschools to assist with completion. Information on data handling and anonymity was provided at the start of the questionnaire.

Questionnaires analyses

An overall well-being score was calculated by averaging the child’s general and preschool well-being ratings (1–5 scale). Survey responses with multiple options were recoded into dichotomous variables: sports participation (organized vs. not), family sports experience (at least one member vs. none), economic situation (good vs. moderate/poor), living situation (one home vs. multiple homes), and home language (only Danish vs. other/mixed).

For family sports experience, responses were grouped into “at least one family member with extensive experience” and “none.” Home language was categorized as “only Danish” or “not only Danish,” and living arrangements as “single residence” or “shared residence.” Sports participation and economic status were similarly dichotomized.

Statistical analysis

Statistical analyses were performed using StataBE (v.17.0.130, StataCorp LLC). Data are presented as raw means (SD) unless otherwise stated.

Descriptive statistics were compiled for each preschool using MABC-2 scores and survey responses. Associations between MABC-2 percentile scores and variables such as well-being were analyzed using sex-adjusted linear regression. Spearman's rank-order correlation was used to examine relationships between MABC-2 scores, well-being, and age, reported with Spearman's rho and scatter plots.

Cohen's d was calculated for significant findings, interpreted using standard thresholds: trivial (< 0.20), small (0.20–0.49), moderate (0.50–0.79), large (0.80–1.19), very large (1.20–1.99), and huge (> 2.00). A significance level of $p < 0.05$ was applied throughout.

Results

Table 2 shows participant characteristics for each of the eight preschools. This descriptive data indicates that the preschools vary in size (34 to 78 children) and sex composition (between 34 and 64% of the children being girls). All descriptive data can be found in Table 2.

Table 2
Descriptive data from each of the participating preschools.

Preschool (no.)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Eligible children (no.)	58	78	58	65	61	65	43	34
Girls (%)	46.6	41.0	63.0	56.9	63.9	44.6	34.9	55.9
Age (mean)	4.3	4.6	4.5	4.5	4.4	4.4	4.2	4.7
Well-being score	1.8	1.6	1.9	1.8	1.6	1.5	1.9	1.9
TS percentile (mean)	39.8	34.2	54.6	60.9	70.0	42.5	50.1	52.5
Under 15th TS percentile (%)	22.4	24.4	15.2	4.6	4.9	18.5	9.3	17.7
Single residency (%)	84.9	92.1	95.5	95.0	100.0	97.4	92.6	94.4
Self-reported good economy (%)	51.6	43.2	63.6	60.0	47.4	27.0	59.3	61.1
Sports club active (%)	48.5	50.0	87.0	53.7	66.7	31.6	37.0	55.6
Extensive sports experience in the family (%)	54.6	52.6	90.9	55.0	74.4	47.4	59.3	77.8
Only speaks Danish (%)	36.4	39.5	90.9	75.0	87.2	26.3	92.6	83.3
Values in mean (SD)								

Subgroup analyses

Table 3 presents the means (SD) for MABC-2 percentile scores and well-being across various subgroups. Linear regression analyses revealed that girls scored significantly higher than boys on the total MABC-2 percentile score (d = 0.38, 95% CI: 0.15–0.56, p = 0.001), manual dexterity (d = 0.46, 95% CI: 0.28–0.66, p < 0.001), and balance skills (d = 0.37, 95% CI: 0.17–0.58, p < 0.001). No significant sex differences were found in aiming and catching skills (p = 0.350).

Children who participated in leisure-time sports clubs demonstrated better performance in aiming and catching (d = 0.27, 95% CI: 0.01–0.52, p = 0.030) and balance skills (d = 0.29, 95% CI: 0.03–0.56, p = 0.047) compared to non-participants. Additionally, children from families with high leisure-time sports experience had significantly higher total scores (d = 0.32, 95% CI: 0.05–0.60, p = 0.027). No other significant differences were observed in relation to sports club participation (p > 0.05).

Children with older siblings scored higher on the total MABC-2 (d = 0.27, 95% CI: 0.00–0.54, p = 0.041) and balance skills (d = 0.30, 95% CI: 0.03–0.56, p = 0.024) than those without older siblings. Furthermore, children living in single residency arrangements outperformed those in shared residency in aiming and catching (d = 0.60, 95% CI: 0.01–1.21, p = 0.049) and reported higher well-being (d = 0.54, 95% CI: 0.01–1.06, p = 0.044).

Children who spoke languages other than Danish at home reported significantly higher well-being scores compared to those who spoke only Danish (d = 0.38, 95% CI: 0.12–0.64, p < 0.001). No significant differences were found in any outcome variable related to economic status (p > 0.05).

Table 3
MABC-2 percentile scores and well-being for different subgroups.

Girls	**N**	**Well-being**	**TS**	**MD**	**AC**	**BA**
	129–190	**1.7 (0.1)**	**55.7 (32.0)***	**50.1 (30.5)***	**57.6 (27.2)**	**55.2 (34.0)***
Boys	126–200	1.8 (0.0)	44.4 (31.3)	36.2 (30.1)	60.3 (29.0)	43.1 (31.3)
Children active in sports clubs	120–136	1.7 (0.5)	55.0 (32.6)	44.7 (31.9)	64.1 (27.3)#	55.8 (33.1)#
Children not active in sports clubs	102–124	1.8 (0.6)	48.3 (32.4)	41.2 (30.8)	56.5 (30.1)	46.1 (33.3)
Family with high sports experience	137–161	1.7 (0.4)	56.0 (32.4)¤	44.9 (30.4)	63.2 (28.8)	54.9 (32.5)
Family without high sports experience	84–98	1.8 (0.7)	45.6 (32.1)	40.5 (32.7)	56.0 (28.5)	45.7 (34.4)
Have older siblings	131–154	1.7 (0.5)	55.5 (33.4)&	44.9 (32.4)	61.4 (29.3)	55.4 (33.0)&
No older siblings	91–106	1.7 (0.6)	46.8 (30.8)	40.3 (29.8)	59.2 (28.1)	45.6 (33.4)
Single residency	210–244	1.7 (0.5)§	52.3 (32.6)	43.3 (31.2)	61.2 (29.2)§	50.8 (33.3)
Shared residency	11–15	2.0 (0.5)	47.5 (34.4)	42.0 (35.3)	43.9 (15.1)	63.8 (36.8)
Only speaks Danish at home	138–166	1.8 (0.4)	55.2 (31.4)	45.2 (30.5)	61.1 (27.9)	54.1 (32.6)
Other language spoken at home	83–93	1.6 (0.6)@	46.9 (34.0)	39.9 (32.5)	59.2 (30.5)	47.0 (34.8)
Good economy	113–129	1.8 (0.4)	52.6 (31.9)	44.1 (30.7)	59.8 (28.5)	51.3 (32.1)
Average or poor economy	108–130	1.7 (0.6)	51.5 (33.4)	42.6 (32.1)	61.0 (29.4)	51.6 (35.1)

TS = Total score, MD =Manual Dexterity, AC =Aiming & Catching, BA =Balance, * = better than boys, # = better than non-sports active children, ¤ better than children from families without high sports club experience, & = better than children without older siblings, § = better than children with shared residency, @ = better than children only speaking Danish at home.

Correlations between MABC-2 and well-being and age.

Figure 1 and 2 show the Spearman correlation plots of the correlations between MABC-2-scores and well-being, and MABC-2-scores and age, and Table 4 shows the associated rho- and p-values. No

significant associations were found between neither well-being nor age and any of MABC-2 percentile scores.

Table 4
Correlations between MABC-2-scores, well-being and age.

	Well-being			Age		
	n	**rho**	***p***	**n**	**rho**	***p***
Total score	220	0.0017	0.981	369	-0.0406	0.436
Manual dexterity	231	-0.0741	0.262	387	-0.0576	0.258
Aim and catch	232	-0.0482	0.465	289	0.0520	0.306
Balance	222	0.0870	0.197	375	0.0717	0.166
*= significant						

Discussion

This study explores potential determinants of motor skills in children aged 3–6 years, focusing on age, sex, socioeconomic status (SES), sports participation og both children and parents, residential arrangement, home language, and well-being using the Movement Assessment Battery for Children – Second Edition (MABC-2) and parent questionnaire.

Girls outperformed boys on the total MABC-2 score and the subscales for balance and manual dexterity, with no sex differences in aiming and catching. Participation in organized sports was associated with better performance in aiming and catching and balance, while children from sport-engaged families showed higher overall scores. Children in single-parent households scored higher in aiming and catching and reported greater well-being than those in shared custody. Multilingual children also reported higher well-being. No significant associations were found between SES and motor performance or well-being, nor between total MABC-2 scores and well-being.

Table 2 reveals substantial variation in mean MABC-2 Total Scores across preschools (range: 34.2–70; expected mean: 50), and in the proportion of children scoring at or below the 15th percentile (4.6%–24.4%; expected: 15%). Notably, the preschools with the highest and lowest proportions were located within the same municipality. Variation in motor skills is likely influenced by multiple factors. In addition to individual and family-level determinants, contextual influences such as the physical environment and opportunities for play may play a significant role (Logan et al., 2012), as well as educators' attitudes and knowledge regarding physical activity (Mikkelsen, 2011; Telford et al., 2022). Furthermore, lower child-to-staff ratios may support motor development (Christoffersen, 2014). Future research should investigate institutional pedagogies, the integration of movement into daily routines, and municipal policies (Mikkelsen, 2011).

Individual-level correlations

Girls outperformed boys on the MABC-2 total score, manual dexterity, and balance, with no sex differences in aiming and catching. These findings align with previous research (Barnett et al., 2016; Iivonen & Sääkslahti, 2014; Zheng et al., 2022; Hardy et al., 2010), although boys are often reported to excel in ball-related tasks. The MABC-2 is standardized without accounting for sex differences (Henderson, 2007). Sex differences are likely rooted in biopsychosocial factors (Lewicki et al., 2018), extending beyond motor skills to encompass domains such as language, cognition, and social development. However, biological differences alone do not fully account for why boys outperform girls in ball-related skills in some studies. Ball games involve a complex interplay of gross and fine motor skills, hand-eye coordination, spatial awareness, appropriate force application, and timing (Henderson, 2007). Peric et al. (2017) argue that differences in brain function contribute to developmental disparities between boys and girls. In addition, societal influences—including gender-specific stereotypes—play a significant role (Peric et al., 2017). For example, boys may perform better in catching due to more frequent engagement in ball games, whereas girls may excel in balance and jumping activities because they are more likely to participate in games that emphasize these skills (McKenzie et al., 2002). Cultural norms are likely to exert greater influence than biological factors, as children begin to develop gender stereotypes and gender identity as early as 2 to 3 years of age (Reigeluth, 2023).

The BPiP study found no significant associations between children's well-being and motor skill domains or sex, suggesting that well-being may not be a reliable indicator of motor competence in preschoolers. This aligns with previous findings showing weak or no correlations between motor and social-emotional skills in typically developing children (Salaj & Masnjak, 2022; Ecevit & Şahin, 2021). However, children diagnosed with Developmental Motor Coordination Disorder (DMCD) show reduced well-being from age four (Mancini et al., 2024), indicating a possible link in clinical populations. A key limitation across studies is the lack of consistent measures for motor competence and well-being, complicating comparisons. In BPiP, well-being was assessed via parent-reported questionnaires, which may not fully capture children's internal experiences. Additionally, the use of newly developed and translated items may have affected measurement sensitivity. These methodological issues highlight the need for further research into the relationship between motor skills and well-being.

The study found a significant difference in ball skills (aiming and catching) between children participating in organized sports and non-participants, but no differences in overall motor scores, balance, manual dexterity, or well-being. While previous studies report positive associations between physical activity and motor competence (Adank et al., 2018; Jones et al., 2020), the BPiP findings suggest this may be limited to specific skills. Similarly, Barnett et al. (2016) found no consistent link between physical activity and object control skills. Discrepancies may stem from methodological differences. BPiP relied on parent-reported participation in organized sports, without specifying activity type. In Denmark, ball games, especially football, are common among 3–6-year-olds (Rask & Toudal, 2021), likely explaining the observed advantage in ball skills. This is supported by Olesen et al. (2014), who found Danish preschoolers perform well in ball skills but lower in general motor coordination. BPiP

does not account for children's physical activity during preschool hours, despite evidence that preschools significantly influence daily activity levels (Olesen et al., 2014). This suggests that overall physical activity may be more relevant to motor development than organized sports alone. According to Rask and Toudal (2021), 82% of Danish children aged 3–6 engage in sports or physical activity weekly, while 12% are inactive. In BPiP, activity levels were generally lower, ranging from 31% to 87% across institutions (see Table 2).

Family-level correlations

In the BPiP study, children living in a single residence performed better in ball skills (aiming and catching) than those in shared residency arrangements (ΔACpercentile = 17.3, $p > 0.05$), although no difference was found in the overall MABC-2 score. The small sample size for shared residency ($n = 15$) limits the validity of this result. The reasons for shared residency were not examined, but existing research primarily focuses on divorce. Kacenelenbogen et al. (2015, 2016) found delayed psychomotor development in young children not living with both parents, particularly in language and drawing skills. Stress related to parental separation may affect development through changes in the HPA axis and could be a contributing factor (Iob et al., 2021). The lack of impact on the overall MABC-2 score may be explained by the Danish context, where children spend more time in daycare than in other Nordic countries (Statistics Denmark, 2011). Research shows that high-quality daycare can positively influence child development, especially for children from lower socioeconomic backgrounds (Dietrichson et al., 2020). Thus, the Danish daycare system may buffer some of the negative effects of parental separation. There is a tendency for children from divorced families to participate less in organized sports, which may contribute to the lower ball skill scores observed among children in shared residency in the BPiP study (Noel-London et al., 2021; Ottosen & Stage, 2011).

In the BPiP study, a negative association was found between living in multiple households and children's well-being ($\Delta = 0.3$, $p > 0.05$), consistent with research demonstrating long-term consequences of divorce on child well-being (Amato, 2005; Frimmel et al., 2024; Nielsen et al., 2025).

Socioeconomic background may also influence motor development, although findings are mixed. Some studies report a clear association (Pedersen et al., 2019; Barnett et al., 2016; Golding et al., 2014; Lingam et al., 2009), while others find no significant link (Veldman et al., 2018; Faebo Larsen et al., 2013). In BPiP, no correlation was found between self-reported economic status and motor outcomes, although the measure lacked detail, such as parental education level.

In the BPiP study, it was observed that children from families with a history of participation in leisure-time sports clubs achieved a higher overall score (DTSpercentile = 10.7, $P > 0.05$) compared to their peers. As mentioned in the introduction, there is a well-documented association between parental physical activity levels and those of their children (Rodrigues et al., 2017; Huilan et al.; Aggestrup & Troelsen, 2017; Dellert & Johnson, 2014). Part of the explanation for the higher scores may lie in the fact that children in the BPiP cohort with physically active parents are more likely to be physically active. However, since the BPiP results indicate that physically active children only show improvement in ball

skills and not in the overall score, this can only partially account for the observed difference. Research has shown that adults with strong motor competencies tend to be more physically active. A study by Utesch et al. demonstrated a moderate to strong positive correlation between motor competence and physical performance, which strengthens with age (Utesch et al., 2019). A similar trend has been observed among adolescents (Burton et al., 2023). It is therefore plausible that the physically active parents in the BPiP study possess well-developed motor skills. This may suggest a genetic predisposition in their children toward better motor abilities, as motor development is a result from a dynamic interaction between biological factors—including genetics—psychological, and social influences (Shumway-Cook A, 2023).This could be reflected in the higher MABC-2 scores observed in the BPiP results. Another possible explanation for the superior overall performance of children with physically active parents is the presence of a movement-oriented culture in the home. Such a culture may promote physical play and activity, enhancing children's motor competence even in the absence of formal sports club participation. As previously noted, research has highlighted the central role of parents in motivating and supporting their children's physical activity, with strong evidence underscoring the significance of parental influence (Aggestrup & Troelsen, 2017; Huilan et al.).

In BPiP, no motor skill differences were found between children who speak languages other than Danish and those who speak only Danish, suggesting limited impact of cultural background on motor competence. This aligns with findings from the Danish National Centre for Social Research (SFI, 2004), which reported no developmental differences between ethnic minority and ethnic Danish children. Although a UK study found lower fine motor skills in infants from Pakistani and Bangladeshi backgrounds (Kelly et al., 2006), such trends were not observed in older children, possibly due to the equalizing effect of preschool education.

Children speaking other languages at home reported higher well-being in BPiP, though based on parent reports and with high variability. Previous research (SFI, 2004) found only weak and inconclusive links between ethnic minority status and well-being. In BPiP, ethnicity was inferred solely from language use, limiting deeper analysis. It should be noted that in this study, ethnicity was assessed solely based on whether more than one language is spoken at home. This limits the ability to draw deeper conclusions about the role of ethnicity.

Strenghts and limitations.

This study has several methodological strengths that enhance the reliability and validity of the findings. Firstly, the use of the MABC-2, a validated and internationally recognized tool for assessing motor competence in children, strengthens the credibility of the motor assessments. Secondly, the testing personnel underwent standardized training, including video-based scoring exercises and discussions of scoring criteria, which improved inter-rater reliability and ensured consistency across testers. In addition, the parent questionnaire was pilot-tested with both experts and parents from other preschools, allowing for revisions that improved clarity and reduced respondent burden. This process enhanced the validity of the self-reported data. Finally, the motor assessments were conducted in the children's own preschool

settings. This familiar and comfortable environment likely supported more natural behavior and reduced test-related anxiety, thereby increasing the ecological validity of the results.

Despite these strengths, the study also presents several limitations that should be considered when interpreting the findings. First, cross-sectional design restricts the ability to draw causal inferences between parental characteristics and children's motor competence. The findings reflect associations only, and longitudinal data would be needed to determine directionality or causality. Second, the use of self-reported data from parents introduces the potential for reporting bias. Parents may overestimate or underestimate their own physical activity levels or their child's participation in physical activities, which could lead to information bias. Third, variations in test conditions across preschools may have influenced the children's performance. Differences in the physical setup of test rooms, as well as the fact that not all children wore appropriate footwear during testing, may have affected motor outcomes and reduced measurement consistency. Fourth, the generalizability of the results may be limited due to the recruitment strategy. Municipalities participating in the study were already engaged in a national movement initiative, potentially leading to a sample that is more physically active or health-conscious than the general population. Lastly, although all testers received standardized training, the relatively short training duration of three hours may have been insufficient given the complexity of the Movement ABC-2 test, particularly for testers with limited prior experience working with young children or administering this specific assessment tool.

Conclusion

The BPiP study demonstrates that children's motor development is influenced by a range of factors, though the relationships are often complex and not straightforward. No clear association was found between well-being and motor competence in typically developing children, and socioeconomic status showed only limited significance, possibly due to measurement limitations.

Participation in organized sports and a movement-oriented family culture appear to enhance ball skills in particular. Children in shared custody arrangements performed less well in certain areas, potentially due to lower sports participation and increased stress. Substantial differences between institutions highlight the importance of physical environments, pedagogical practices, and municipal policies. Further research is needed to explore the structural and cultural conditions of Danish early childhood education settings.

Abbreviations

MABC-2
Movement ABC-2
BPiP
Ball-based Play in Preschool
DIF

Sports Confederation of Denmark
TS
Total score
MD
Manual Dexterity
AC
Aiming & Catching
BA
Balance

Declarations

Conflicts of interest.

The authors declare no conflicts of interest.

Ethics approval and consent to participate

Consent for publication Availability of data and materials Competing Interests: Following Danish law (LBK no. 1338 of 1/9/2020) and review by the Ethics Committee of Southern Denmark (case: 20232000-77), no formal ethical approval was required, as no biological material was collected. The study was approved by the Research and Innovation Organization (RIO) at the University of Southern Denmark (review no. 11.944).

Consent for Publication:

Consent for publication refers to consent for the publication of identifying images or other personal or clinical details of participants that compromise anonymity. This is not applicable to the manuscript.

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Author Contribution

LBC and MNL designed the study and secured funding. All collected and interpreted the data. CBM conduced statistical analysis. VG wrote original draft. All authors revised the manuscript critically.

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Availability of data and materials upon reasonable request to the corresponding author.

Data Availability

Data is available upon reasonable request to the corresponding author.

Figures

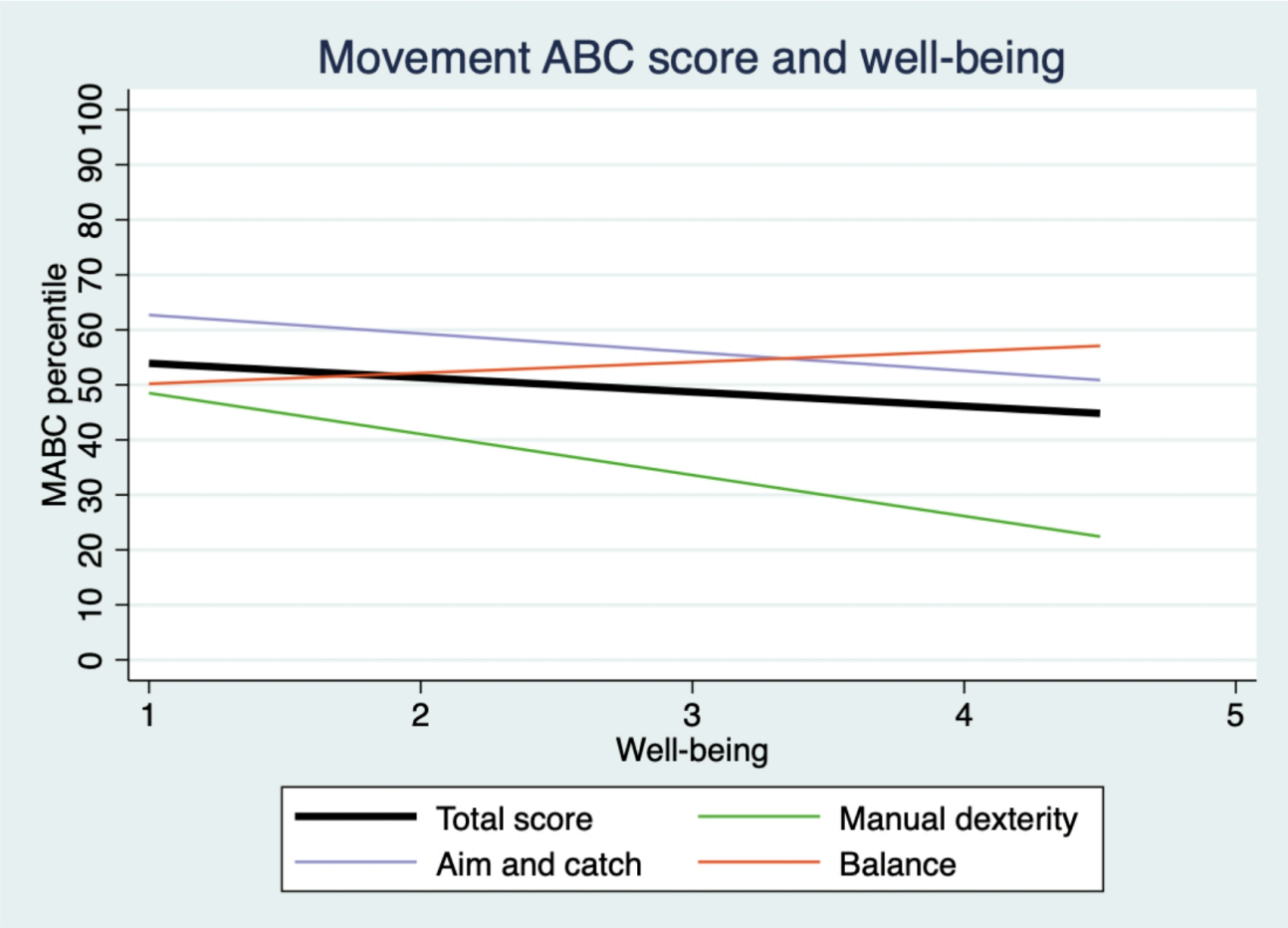


Figure 1

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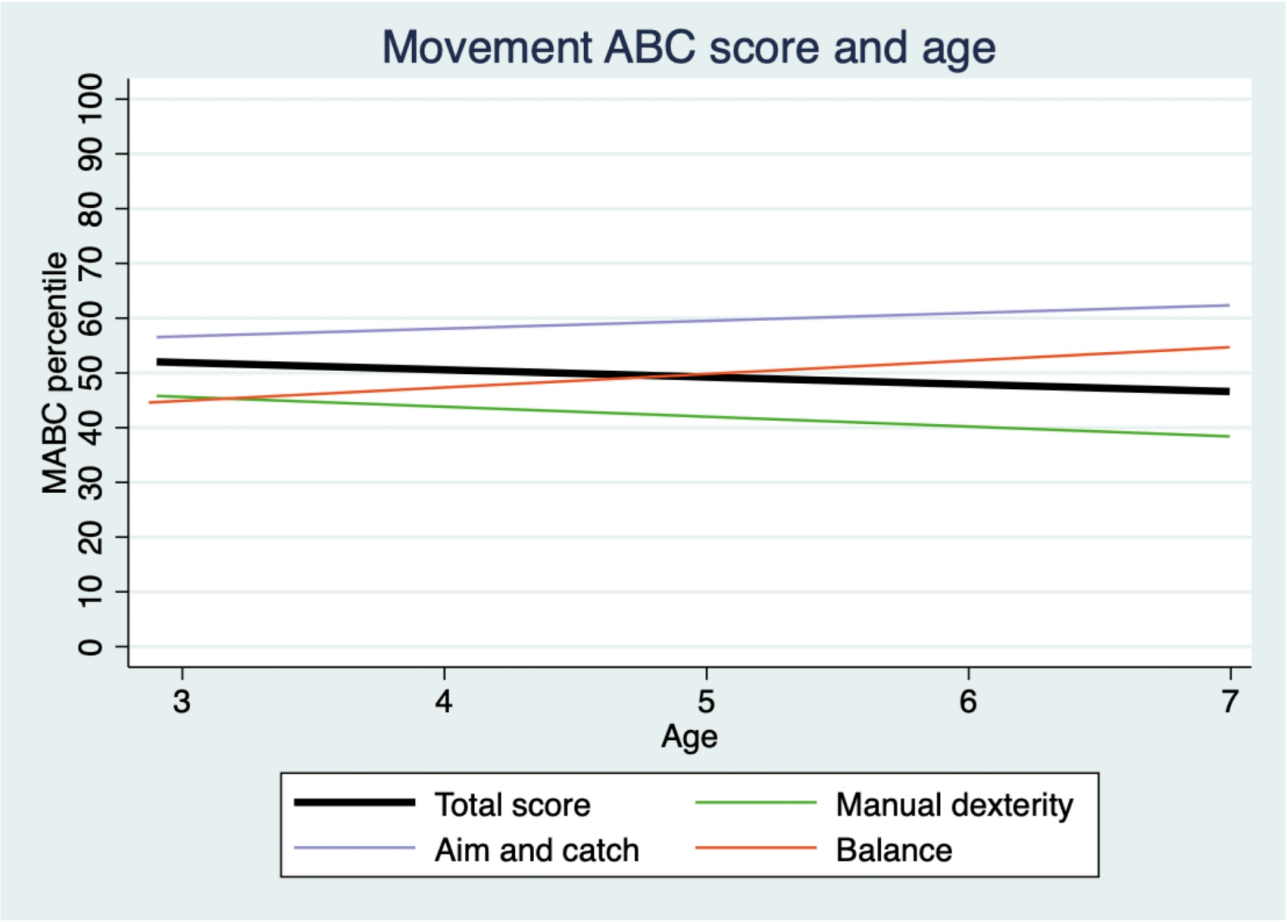


Figure 2

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