

Motor competence in primary school children: A comparative study of two assessment methods

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Abstract:

Methods for assessing motor competence in children vary internationally, but it is still debated whether the commonly used tests measure comparable aspects of motor performance. This study compared two motor competence assessment tools—the Körperkoordinationstest für Kinder (KTK) and the MOBAK 3–4 test, while also examining how gender, age, and BMI influenced their outcomes. A total of 101 primary school children (M = 9.41 years, SD = 0.56; 46.53% girls) participated in this cross-sectional study. Bivariate Pearson correlations were used to examine the association between the KTK and MOBAK 3–4 test assessments. Additionally, partial correlations were performed to control for the covariates: gender, age, and BMI. The motor quotient (KTK) demonstrated a moderate correlation with the object movement (OM) area ($r = .396$, $p < .05$), a stronger correlation with the self-movement (SM) area ($r = .459$, $p < .01$), and the highest correlation with the overall MOBAK score ($r = .525$, $p < .01$). After controlling for gender and age, a weak correlation was observed between MQ (KTK) and OM ($r_p = .286$, $p = .004$), while moderate correlations were found between MQ (KTK) and SM ($r_p = .409$, $p < .001$), as well as between MQ (KTK) and the MOBAK score ($r_p = .443$, $p < .001$). Given the weak to moderate correlations between the KTK and MOBAK 3–4, experts should be cautious of potential categorization errors when relying on a single test. This study highlights the relationship between KTK and MOBAK 3–4, reinforcing the importance of using multiple assessment instruments for a comprehensive evaluation of MC.

Key Words: MOBAK; KTK; motor development; childhood

Introduction

Basic motor competencies (MCs) are essential movement skills required for a broad range of activities (Herrmann et al., 2017). MC plays a crucial role in development (Adolph & Hoch, 2019) and serves as a predictor of childhood physical activity (Eldiasty et al., 2023; Wälti et al., 2023) because it is related to increased participation in games and other physical activities (Coppens et al., 2021). Logan et al. (2018) define MC as a broad term encompassing various aspects of human motor skills, including motor proficiency, fundamental motor skills, motor ability, and motor coordination. Although these terms overlap conceptually, they represent distinct constructs. In this context, Lopes et al. (2021) note that no universally accepted definition of MC currently exists.

In recent years, debates have emerged regarding the need for targeted test instruments in physical education (PE) (Barnett et al., 2016; Irish Primary PE Association, 2015) to identify students requiring additional support or to assess motor proficiency levels (Gerlach et al., 2017; Herrmann et al., 2015).

Existing test instruments differ in their theoretical frameworks because they are based on concepts such as "motor abilities," "motor skills," or "motor competencies" (Gerlach et al., 2017). The construct of fundamental motor competencies differs from that of specific motor skills. Motor skill tests focus on identifying the procedural aspects of motor performance, such as movement quality, while successful task completion is not the core of the assessment. In contrast, motor competencies emphasize the successful execution of motor tasks, such as throwing at a target, among others (Herrmann & Seelig, 2017b; Herrmann & Seelig, 2017a). These variations highlight the need for comparative research on the motor tasks used across different test instruments.

A variety of standardized instruments are used globally to assess motor competencies (MCs) in children, reflecting the growing emphasis on motor development as a key component of overall child health and education. Among these, the KTK is one of the most widely used assessments (Bardid et al., 2016; Moreira et al., 2019; S. Platvoet et al., 2018). Developed in Germany, it is designed to assess children and adolescents aged 5–14 (Kiphard & Schilling, 1974, 2007). The primary purpose of the KTK is to identify movement difficulties, particularly those related to motor coordination components such as balance, rhythm, strength, laterality, and agility (Nascimento et al., 2019; Campbell-Pierre & Rhea, 2023). Research shows that the KTK has been extensively utilized across various countries, including Australia (Bardid et al., 2015), several European nations

(Laukkanen et al., 2020), Brazil (Moreira et al., 2019), the United States (Campbell-Pierre & Rhea, 2023), China (Li et al., 2023), and Indonesia (Adriyani et al., 2019; Mardiansyah et al., 2023).

Fransen et al. (2014) reported a significant positive correlation between BOT-2 motor tasks and KTK test performance in a cohort of 2,585 children, divided into three age groups (6–7, 8–9, and 10–11 years). Their analysis found no significant differences between sexes or age categories. These results align with those of Bardid et al. (2016), who investigated the relationship between KTK test scores and MOT 4–6. Ré et al. (2018) reported low-to-moderate correlations when evaluating MC in children aged 5–10 years using these two test batteries. These results suggest that while both assessments evaluate aspects of MC, they likely measure distinct components of the construct to some degree.

Several studies have examined various motor assessment tools and highlighted inconsistencies in their outcomes, often attributed to the diverse influence of external factors on the specific motor skills evaluated (Fransen et al., 2014; Hanewinkel-van Kleef et al., 2009). Given the widespread use and acceptance of the KTK in the scientific community, it is crucial to explore whether other assessment tools also correlate with the KTK. This would help generate more valid and reproducible data, ultimately improving comparability across studies. Based on the above mentioned facts, the aim of our study was to compare two MC assessment tools: the KTK and the MOBAK 3–4 test instrument, and to examine the relationship between gender, age, and BMI with these MC assessments.

Material & methods

Participants

A total of 101 children ($M = 9.41$ years, $SD = 0.56$; 46.53% girls) participated in this cross-sectional study. Participants were categorized into third grade ($n = 59$, $M = 9.05$ years, $SD = .33$; 52.5% girls) and fourth grade ($n = 42$, $M = 9.92$ years, $SD = .39$; 38.1% girls) groups. Participants were selected from three primary schools located in eastern Slovakia, with written informed consent obtained from their parents or legal guardians. The research protocol received approval from the Ethics Committee of the University of Presov (ECUP102023PO, 2023). All procedures adhered to the ethical standards set forth in the Declaration of Helsinki.

Procedure

Body height and body weight were measured to calculate BMI (kg/m^2), which was used as a covariate for MCs. The basic anthropometric characteristics in terms of age and gender are presented in Table 1.

Table 1. Anthropometric characteristics of participants by gender and grade

	n	Age (years)		Height (cm)		Weight (kg)		BMI (kg/m^2)	
		M	SD	M	SD	M	SD	M	SD
Boys	54	9.49	0.57	14.69	6.59	35.27	7.98	17.67	2.85
Girls	47	9.33	0.53	137.38	6.08	33.10	6.46	17.44	2.70
Third grade	59	9.05	0.33	136.00	5.22	32.65	6.42	17.56	2.77
Fourth grade	42	9.92	0.39	143.58	5.63	36.52	8.05	17.57	2.81
Total	101	9.41	0.56	139.15	6.57	34.26	7.39	17.56	2.78

Note: M = mean; SD = standard deviation

All participants completed both the MOBAK 3–4 and KTK assessments within a one-month timeframe in 2024. The evaluations were carried out over two separate days, with sufficient recovery time between individual test items (Table 2). During the schools' regular 45-minute physical education classes held in the gymnasiums, the MOBAK 3–4 (Herrmann, 2018) and KTK (Kiphard & Schilling, 1974; 2007) assessments were administered by two trained evaluators.

Table 2. Items in the MOBAK 3–4 and KTK assessments

MOBAK 3–4		KTK
Object movement	Self-movement	
throwing	balancing	walking backward
catching	rolling	hopping for height
bouncing	jumping	jumping sideways
dribbling	running	moving sideways

Basic motor competence assessment (MOBAK 3–4)

The MOBAK test instruments consist of two competence areas: self-movement (SM) and object movement (OM). The specific test items for each domain are presented in Table 2. For throwing and catching, each participant performs a total of six attempts per item without any practice trials. Every successful attempt (hitting the target or catching the ball) is recorded. A score of 0 points is assigned for 0 to 2 successful attempts,

1 point for 3 to 4 successful attempts, and 2 points for 5 to 6 successful attempts. For the remaining items, each child performed two attempts, scored as follows: 0 points if both attempts were unsuccessful, 1 point for one successful attempt, and 2 points if both were completed successfully (Herrmann, 2018). Test results can be evaluated at the level of each individual test item, at the level of the specific competence domains, as well as by the overall score of the MOBAK test battery. The assessment of the competence domains in the MOBAK test is based on the sum of the scores from the four corresponding test items. For each competence domain, a maximum of 8 points can be achieved, as each of the four test items is scored from 0 to 2 points. Children completed all test items following the MOBAK 3–4 protocol (Herrmann, 2018).

Gross motor coordination (KTK)

The assessment of gross motor coordination was performed using the KTK (Kiphard & Schilling, 1974; Kiphard & Schilling, 2007). The KTK consists of four tasks, which are presented in Table 2.

Raw scores for each KTK test item were transformed into standardized scores based on age and gender, following the normative data provided in the KTK manual. The motor quotient (MQ) was then derived by adding the standardized scores across all test items ($MQ = MQ1 + MQ2 + MQ3 + MQ4$). The age- and gender-adjusted MQ (KTK) allows for the assessment of gross motor coordination in the following categories: *impaired* (KTK MQ 56–70; $\leq$ 2nd percentile), *poor* (KTK MQ 71–85; Third – 16th percentile), *normal* (KTK MQ 86–115; 17th – 84th percentile), *good* (KTK MQ 116–130; 85th – 98th percentile), or *high* (KTK MQ 131–145; $\geq$ 99th percentile) (Kiphard & Schilling, 1974; Kiphard & Schilling, 2007).

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics (IBM Corp., 2021). Descriptive statistics, including means (M) and standard deviations (SD), were calculated for the MC assessment instruments KTK and MOBAK 3–4 across gender and school grades. Effect size was assessed using Cohen's d , with values of $d = .2$, $d = .5$, and $d = .8$ interpreted as small, medium, and large effects, respectively (Cohen, 1992). To examine the associations between the KTK and MOBAK 3–4 MC assessments, bivariate Pearson correlation coefficients were computed. For consistency across measures, the MOBAK 3–4 (OM and SM) and KTK MQ were standardized using Z-score transformation. The analyses also included partial correlations, adjusting for the potential influence of gender, age, and BMI.

Results

The results show moderate gender differences in both the MOBAK 3–4 and KTK test assessments (Table 3). Boys scored significantly higher than girls in OM ($t(99) = 3.19$, $p < .01$) and total MOBAK score ($t(99) = 2.35$, $p < .05$), while the differences in SM were minimal ($t(99) = 0.65$, $p = .52$). Additionally, boys outperformed girls in the MQ (KTK) ($t(99) = 1.93$, $p = .06$). When comparing across grade levels, fourth-grade students scored significantly higher than third-grade students in all MC variables, with large effect sizes observed for OM ($t(99) = -2.98$, $p < .01$), SM ($t(99) = -4.21$, $p < .01$), MOBAK score ($t(99) = -4.45$, $p < .01$), and MQ (KTK) ($t(99) = -6.57$, $p < .01$). Based on standardized MQ (KTK) classifications, third-grade students were categorized as "poor," while fourth-grade students were classified as "normal" (Table 3).

Table 3. Comparison of motor performance of participants by gender and grade

Indicator	Boys		Girls		<i>t-test</i>	<i>p-value</i>	Cohen's <i>d</i>
	M	SD	M	SD			
OM	4.61	1.60	3.57	1.67	3.19	.002	0.64
SM	3.44	1.68	3.23	1.67	0.65	.517	0.13
Mobak score	8.06	2.57	6.77	2.88	2.35	.021	0.47
MQ (KTK)	96.09	16.76	88.11	2.43	1.93	.056	0.43
Third grade				Fourth grade			
	M	SD	M	SD			
OM	3.71	1.55	4.71	1.74	-2.98	.004	.61
SM	2.80	1.51	4.12	1.58	-4.21	< .001	.86
Mobak score	6.47	2.33	8.83	2.84	-4.45	< .001	.93
MQ (KTK)	84.02	18.30	104.12	12.45	-6.57	< .001	1.25

Note: OM (0–8 points); SM (0–8 points); Mobak score (0–16 points); M = mean; SD = standard deviation; OM = object movement; SM = self-movement; MQ (KTK) = motor quotient; boys: $n = 54$; girls: $n = 47$; third grade: $n = 59$; fourth grade: $n = 42$

Table 4 shows the results of the correlation analysis between MOBAK 3–4 and KTK. There was a moderate positive correlation between OM and SM ($r = .350$, $p < .05$). Strong positive correlations were identified between OM and overall MOBAK score ($r = .827$, $p < .01$), as well as between SM and the MOBAK score ($r = .812$, $p < .01$). The MQ (KTK) demonstrated a moderate correlation with OM ($r = .396$, $p < .05$), a stronger correlation with SM ($r = .459$, $p < .01$), and the highest correlation with the MOBAK score ($r = .525$, $p < .01$).

Table 4. Bivariate correlations between MOBAK and KTK

		OM	SM	MOBAK score	MQ (KTK)
OM	<i>r</i>	-			
SM	<i>r</i>	.350*	-		
MOBAK score	<i>r</i>	.827**	.812**	-	
MQ (KTK)	<i>r</i>	.396*	.459**	.525**	-

Note: Pearson's correlation coefficients (*r*) are reported. Gender is coded as 1 = boys, 2 = girls. OM = object movement; SM = self-movement; MQ (KTK) = motor quotient; * $p < .05$; ** $p < .01$

Table 5 shows the results of the bivariate correlations between the MOBAK and KTK assessments and the covariates gender, age, and BMI. Gender shows a weak negative correlation with OM ($r = -.306$, $p = .002$) and the MOBAK score ($r = -.233$, $p = .019$). Age is moderately positively correlated with OM ($r = .399$, $p < .001$), the MOBAK score ($r = .435$, $p < .001$), and MQ (KTK) ($r = .290$, $p = .003$). BMI demonstrates a weak correlation with motor performance variables, with no significant associations except for OM ($r = .298$, $p = .002$). The MOBAK score is moderately correlated with MQ (KTK) ($r = .525$, $p < .001$), even after controlling for gender, age, and BMI.

Table 5. Bivariate correlations between MOBAK and KTK with the covariates gender, age, and BMI

		OM	SM	MOBAK score	MQ (KTK)	Gender	Age	BMI
OM	<i>r</i>	-						
SM	<i>r</i>	.350**	-					
MOBAK score	<i>r</i>	.827**	.812**	-				
MQ (KTK)	<i>r</i>	.396**	.459**	.525**	-			
Gender	<i>r</i>	-.306**	-.063	-.233*	-.212*	-		
Age	<i>r</i>	.399**	.308**	.435**	.290**	-.143	-	
BMI	<i>r</i>	.298**	-.078	.121	-.052	-.042	.049	-

Note: Pearson's correlation coefficients (*r*) are reported. Gender is coded as 1 = boys, 2 = girls. OM = object movement; SM = self-movement; MQ (KTK) = motor quotient; * $p < .05$; ** $p < .01$

Table 6 presents partial correlations between the MOBAK 3–4 and KTK test assessments, controlling for gender and age as covariates. After adjusting for gender and age, a weak correlation is observed between MQ (KTK) and OM ($r_p = .286$, $p = .004$), while moderate correlations are found between MQ (KTK) and SM ($r_p = .409$, $p < .001$), as well as the total MOBAK score ($r_p = .443$, $p < .001$).

Table 6. Partial correlations between MOBAK and KTK with the covariates gender and age

		OM	SM	MOBAK score	MQ (KTK)
OM	r_p	-			
SM	r_p	.265**	-		
MOBAK score	r_p	.783**	.803**	-	
MQ (KTK)	r_p	.286**	.409**	.443**	-

Note: Partial correlation coefficients (r_p) are reported. Gender is coded as 1 = boys, 2 = girls; OM = object movement; SM = self-movement; MQ (KTK) = motor quotient; * $p < .05$; ** $p < .01$

Table 7 shows the correlation coefficients and significance levels for OM, SM from the MOBAK test assessment, the four KTK test items, and MQ (KTK). In the KTK test items, weak to moderate positive correlations were observed between MQ1, MQ2, and MQ3 and OM ($r = .237 - .418$), as well as between MQ1, MQ2, MQ3, MQ4, and SM ($r = .308 - .525$). Weak to moderate correlations were also found between the KTK test items and the MOBAK total score ($r = .259 - .580$). Additionally, KTK test items are correlated with one another, with values ranging from $r = .396$ to $r = .631$, indicating that all items collectively contribute to the overall MQ (KTK).

Table 7. Bivariate correlations between the 4 KTK items (MQ1–MQ4), the MOBAK assessment, and MQ (KTK)

		OM	SM	MOBAK score	MQ (KTK)
MQ1	<i>r</i>	.274**	.282**	.334**	.528**
MQ2	<i>r</i>	.237*	.320**	.348**	.750**
MQ3	<i>r</i>	.418**	.372**	.491**	.879**
MQ4	<i>r</i>	.214*	.405**	.370**	.801**

Note: Pearson's correlation coefficients (*r*) are reported. OM = object movement; SM = self-movement; MQ (KTK) = motor quotient; MQ1 = walking backwards; MQ2 = hopping for height; MQ3 = jumping sideways; MQ4 = moving sideways; * $p < .05$, ** $p < .01$

After controlling for gender and age, MQ3 (jumping sideways) shows the strongest correlation with the MOBAK score ($r_p = .335$, $p < .001$), followed by MQ1 (walking backwards) and the MOBAK score ($r_p = .367$, $p < .001$). Several weaker or non-significant relationships were observed, such as between OM and MQ2 ($r_p = .145$, $p = .153$), as well as between OM and MQ4 ($r_p = .131$, $p = .197$).

Discussion

This study compared two MC assessment tools (the KTK and MOBAK 3–4) and examined the relationship between gender, age, and BMI as covariates in these assessments. Our findings indicate moderate gender differences in the OM domain, the MOBAK total score, and the MQ (KTK), with boys generally performing slightly better. Scores in the SM domain were nearly identical, suggesting no significant gender-related differences. Several previous studies using the MOBAK test batteries have consistently demonstrated higher performance of boys in object movement domain, whereas girls tend to show higher proficiency in the self-movement domain (Strotmeyer et al., 2020; Herrmann et al., 2019; Quitério et al., 2018). A significant difference in the MQ (KTK), favoring boys, was also reported by Adriyani et al. (2020). Age showed a moderate positive correlation with the OM area, MOBAK score, and MQ (KTK), suggesting that motor performance improves with age. BMI exhibited a weak correlation with motor performance variables, with no significant associations, except for a relationship with the OM area. Weak to moderate positive associations were observed between the MOBAK score and MQ (KTK), as well as across all four KTK test items. These correlations between the total MOBAK 3–4 score and MQ (KTK) indicate that both assessments primarily evaluate general MCs. Our results regarding the relationship between the MOBAK 3–4 and KTK are in line with earlier studies by authors Fransen et al. (2014) and Bardid et al. (2016).

Evidence of similarity between these two testing batteries is partially supported by the moderately significant association between the MOBAK total score and MQ (KTK), as well as between MOBAK SM and MQ (KTK), and the weak but significant relationship between MOBAK OM and MQ (KTK). These findings align with the study by Cools et al. (2010), which examined the relationship between MOT 4–6 (Zimmer & Volkamer, 1984) and the M-ABC (Henderson & Sugden, 1992), where higher correlation coefficients were observed between the gross or fine motor composite scores of each battery. Although these moderate associations are typical in the field of motor assessment, they suggest that each test battery tends to measure different aspects of a similar construct—MC (Bardid et al., 2016).

Additionally, stronger positive correlations were found between the MQ (KTK) and self-movement domain than object movement domain. These strong correlations between the self-movement domain and the motor quotient suggest that the MOBAK 3–4 assessment effectively measures MCs also captured by the MQ (KTK). Our findings are consistent with those reported by Bardid et al. (2016), who found a higher positive correlation between the KTK total score and gross motor score. In our study, several weaker or non-significant relationships were observed, such as between OM and MQ2, MQ4, indicating that activities such as hopping for height and moving sideways may not be directly influenced by OM.

Physical fitness, often overlooked in MC assessment, likely influences performance in KTK tasks such as hopping for height and jumping sideways, which require more strength and endurance than the MOBAK 3–4 tasks. The primary aim of the MOBAK 3–4 is to assess basic MCs that are integral to the PE curriculum and essential for active participation in sports culture. For this purpose, the actual level of fitness is less important.

Because the levels of agreement between the KTK and MOBAK 3–4 are weak to moderate, experts should be cautious of potential categorization errors when using either of these tests. The choice of the appropriate test should be determined based on the specific goals and needs of the study.

Although this study provides valuable insights into MC assessments in primary school children, it has several limitations that should be acknowledged. The limited sample size may restrict the generalizability of the findings, emphasizing the need for larger samples in future research. Additionally, the two MC assessment tools used in this study are based on different theoretical frameworks and measurement constructs. Future research should incorporate longitudinal designs, larger and more diverse samples, and a multi-method assessment approach to offer a more comprehensive understanding of MC in primary school children.

Conclusions

The results showed moderate correlations between the KTK motor quotient and the MOBAK self-movement domain, but weaker associations with locomotor domain, indicating that these assessments measure different yet related aspects of MC. Given the moderate level of agreement between the two assessments and their different underlying constructs, caution should be exercised when relying on a single test for MC evaluation. Future research should further explore the specificity of each instrument to optimize their use in both educational and research settings, thereby enhancing the accuracy of MC diagnostics in children.

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Conflicts of interest

The authors report no conflict of interest.

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