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Original article

Construct and correlates of basic motor competencies in primary school-aged children

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Abstract

Background: A central aim of physical education is the promotion of basic motor competencies (in German: Motorische Basiskompetenzen; MOBAK), which are prerequisites for children's active participation in sports culture. This article introduces the MOBAK-1 test instrument for 6- to 8-year-old children and determines the construct validity of this test instrument. In addition, the relationship between MOBAK and motor ability (i.e., strength) as well as body mass index (BMI), sex, and age is investigated.

Methods: We analyzed data of 923 first and second graders (422 girls, 501 boys, age = 6.80 ± 0.44 years). The children's basic motor competencies were assessed by the MOBAK-1 test instrument. Besides analyses of frequency, correlation, and variance, 3 confirmatory factor analyses with covariates were performed.

Results: We found 2 MOBAK factors consisting of 4 items each. The first factor, *locomotion*, included the items balancing, rolling, jumping, and side stepping; the second factor, *object control*, included the items throwing, catching, bouncing, and dribbling. The motor ability *strength* had a significant influence on the factors *locomotion* ($\beta = 0.60$) and *object control* ($\beta = 0.50$). Older pupils achieved better results than younger pupils on *object control* ($\beta = 0.29$). Boys performed better on *object control* ($\beta = -0.44$), whereas girls achieved better results in *locomotion* ($\beta = 0.07$). Pupils with a high BMI achieved lower performance only on the factor *locomotion* ($\beta = -0.28$).

Conclusion: The MOBAK-1 test instrument developed for this study meets psychometric validity demands and is suitable to evaluate effects of sports and physical education.

Keywords: BMI; Factorial validity; Gross motor skills; Locomotion; Measurement; Object control; Physical education; Strength

1. Introduction

Basic motor competencies are understood as functional performance dispositions. They can be learned and retained in the long term and develop along situation-specific motor demands. The concept of motor competence is currently receiving special attention in educational and health sciences. Robinson et al.[1] described motor competence as "an individual's capacity to coordinate and control their center of mass and extremities in a gravity-based environment". According to this health sciences perspective, motor competence is understood initially as a collective name for various motor performance dispositions (i.e., motor proficiency, motor performance, and fundamental motor skills) that can be learned independently of a particular context. In this regard, motor competencies are clearly distinct from motor abilities or physical fitness (e.g., cardiorespiratory fitness, strength, stamina, and agility).[2,3] At the same time, physical fitness is an elementary and relatively stable component of motor activity and thus an important condition for the development of motor competencies. A recent review confirms that motor competencies are correlated positively with the health variables "physical activity", "perceived competence", and "health-related fitness", and negatively with "weight status".[1]

In educational sciences, the term "competence"[4] is not only used as a collective term for various performance dispositions but is also endeavored to establish an independent construct within motor performance dispositions under the concept of basic motor competencies (in German: Motorische Basiskompetenzen (MOBAK)). Accordingly, what we refer to as basic

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motor competencies is not the performance behavior itself (also termed "performances") but the general performance dispositions behind this behavior. Associated performances are referred to as basic motor qualifications, which can be described as can descriptions (e.g., can throw, can catch) and can be measured by means of test items.[5] On the basis of the combination of these basic qualifications, it is possible to identify the underlying latent structures of basic motor competencies.

Competency diagnostics oriented toward pedagogical norms allow scientists to ask what a child in a particular age group needs to be able to do to participate actively in sport and exercise culture. In doing so, they define age-specific basic motor qualifications that are necessary for achieving basic and situation-specific standards. Only if a child achieves this competency level it can be assumed that he or she will be capable of participating actively in sport and exercise culture. This participation gives the child access to more advanced educational content and helps him or her to acquire motor and health-related competencies. Individuals who possess motor competencies are qualified to access various fields of exercise and to use their learning experiences to build up a physically active lifestyle.[1,6−8]

School curricula provide orientation for the normative definition of the required competency level. They set standards and targets that describe what children in particular age groups should be able to do.

This article introduces MOBAK-1, a test instrument for measuring basic motor competencies in first- and second-grade school pupils (aged 6−8 years). To ensure curricular validity, we aligned the construction of the MOBAK-1 test instrument closely with the targets formulated in the German and Swiss primary school curricula.

Within the context of teaching research, the MOBAK-1 test instrument makes it possible to pursue 3 main goals: an evaluation of the school system provides information that can serve as a basis for targeted improvements in quality. At the school level, monitoring of performance levels can lead to feedback for the individual schools and form the basis for internal school development. In the course of competency diagnostics, pupils in need of special support can be identified and then helped efficiently by means of targeted support measures.[9]

The MOBAK-1 test instrument encompasses a total of 8 items. Four of these items (balancing, rolling, jumping, and sidestepping) cover the basic motor competency *locomotion* and the 4 others (throwing, catching, bouncing, and dribbling) cover the basic motor competency *object control*. Each of these test items consists of standardized tasks and evaluation criteria. For example, the task for the test item rolling is to roll forward ("somersault") and return to a standing position in 1 fluid motion, and the task for the test item bouncing is to bounce a small basketball (size 3, diameter: 17 cm) through a marked corridor (5.0 m × 1.0 m) without losing it (detailed test manual available online[10]). Thus, the MOBAK-1 test instrument not only offers the aforementioned close connection to school curricula, but also a fast test execution and a simple evaluation of the test items.

In a previous study, Herrmann et al.[11] already confirmed the factorial and discriminant validity of the MOBAK-1 test instrument on a sample of $n = 317$ Swiss first graders (143 boys, 174 girls; age = 7.00 ± 0.36 years). The exploratory factor analysis in this study revealed the expected 2-factor structure with a satisfactory model fit (comparative fit index, $CFI = 0.94$; root mean square error of approximation, $RMSEA = 0.056$). Four test items (balancing, rolling, sidestepping, jumping), were assigned to the factor *locomotion*. A further 4 test items (bouncing, dribbling, catching, throwing) constituted the second factor *object control*. As a replication of this structure under the restrictive conditions of the confirmatory factor analysis confirmed by this 2-factor solution ($CFI = 0.96$; $RMSEA = 0.036$), we assumed factorial validity as a whole.

The aforementioned study investigated discriminant *validity* by means of correlative comparisons between established tests for assessing motor abilities (such as side jumps, tapping, standing long jumps, and 20 m sprints) and the MOBAK test items.[5] As expected, this resulted in weak to moderate correlations. Factor analyses conducted on this basis demonstrated that the 2 MOBAK factors are preserved independently of motor abilities. The resulting model was supplemented with the latent factor *strength*, which included the 2 tests standing long jump and 20 m sprint ($CFI = 0.99$; $RMSEA = 0.021$). The factor *strength* showed a moderately significant influence on the MOBAK factors *locomotion* ($\beta = 0.60$) and *object control* ($\beta = 0.50$). This was taken as an indication confirming the theoretical assumption that motor abilities exert an influence on basic motor skills. At the manifest level of the test items as well as the latent level of the factors, it may thus be assumed that the MOBAK-1 test instrument measures a construct that is clearly distinguishable from motor abilities.[5]

The purpose of the present study is to replicate the previous results on the factorial and discriminant validity of the MOBAK-1 test instrument with a further, much larger sample from a different country (Germany). As this sample includes first- as well as second-grade pupils, it will also be possible to test whether the psychometric characteristics of the MOBAK-1 test instrument are preserved over a broad age range of 6 to 8 years. If this were the case, the MOBAK-1 test instrument could be applied in the first as well as the second grades. Furthermore, this study seeks to determine how the MOBAK factors *locomotion* and *object control* are connected with the individual characteristics of age, sex, and body mass index (BMI, weight/height^2), as well as with the motor ability *strength*.

2. Methods

2.1. Participants

In this validation study we analyzed data derived from the Schulkids in Bewegung school project, which was conducted by Sportkreis Frankfurt from September 2014 to July 2015. As part of the evaluation process, Sportkreis Frankfurt collected sociodemographic data as well as motor performance data. Our validation study fully conforms to the Declaration of Helsinki and was approved by Sportkreis Frankfurt, the Directorate of

Education, Culture and Sport of Frankfurt, and the local school managements of the participating primary schools. Children and their parents were informed about the general purpose of the school project and the study, the voluntary nature of participation, and the anonymous handling of data. Next, parents provided informed consent and children assented to participate.

The individual data were collected in classes within the regular teaching time of a 45-min lesson. The classes were divided for this purpose into small groups of 4 to 5 pupils each. One specially trained physical education student was assigned to each group. The tester guided their groups through the test stations and assessed each pupil's performance. The duration of the assessments ranged from 35 to 45 min, which means that approximately 10 min per pupil are needed.

The convenience sample consisted of $n = 923$ first- and second-grade pupils (501 boys, 422 girls) from 18 public primary schools in Frankfurt am Main (South West Germany, 732,000 inhabitants). The assessments of the basic motor competencies took place in the first quarter of the school year (September through October, 2014). Physical education lessons in early grades are taught mixed-gender and include typically developed children as well as children with special educational needs. Children included in the study were between 5.83 and 8.17 years old, attended the first or second class of primary school and were able to attend regular physical education lessons. No further information on the children with special educational needs was available. Children lived in the city of Frankfurt am Main with different population densities: urban (76.8%) and suburban (23.2%). The age of the pupils was recorded to the month and averaged 6.82 ± 0.44 years, range: 5.83−8.17 years (boys: 6.86 ± 0.46 years, range: 5.83−8.17 years; girls: 6.78 ± 0.41 years, range: 5.83−8.08 years).

2.2. Procedures

The MOBAK-1 test instrument was used to measure basic motor competencies. Before measuring each test item, the tester explained the tasks and then gave a one-off demonstration. Two test rounds each (no trial run) were recorded for the 6 test items balancing, rolling, jumping, side stepping, bouncing, and dribbling. We recorded the assessment for each round in a protocol on the basis of a dichotomous scale (not correctly performed = 0 point; correctly performed = 1 point). We then added up the points per test item from the 2 rounds. The pupils had 6 attempts each for the test items throwing and catching. We first recorded the number of successful attempts on these items and then transformed them for the evaluation as follows: 0−2 successful attempts = 0 point, 3−4 successful attempts = 1 point, and 5−6 successful attempts = 2 points). The pupils could achieve a maximum of 8 points for each competency area (*locomotion* and *object control*) on the basis of the 4 relevant test items.

To assess the motor ability *strength*, the test items standing long jump[12] (jumping distance rounded off to full cm) and 20 m sprint[13] (running time accurate to 1% of a second, measured by photoelectric beam) were used. All the children had 2 attempts, and the best of the 2 attempts was recorded.

Furthermore, we measured weight (with a scale precise to 0.1 kg) and height (with a measuring tape precise to 0.5 cm) of each child to calculate related BMI. The mean BMI of the children was 16.19 ± 2.24 kg/m^2 (range: 11.57−26.16 kg/m^2).

2.3. Data analyses

We prepared the data (formation of factor sum values, *z*-transformations) and performed the analyses of frequency, correlation, and variance with SPSS Version 22.0 (IBM Corp., Armonk, NY, USA). Multivariate analyses were performed with the statistics program Mplus 7.11.[14] For these analyses, we *z*-transformed the values of the test items standing long jump and 20 m sprint on the basis of the total sample. For presentation purposes, we also inverted the *z*-values of the test item 20 m sprint so that a higher value meant better performance. For the descriptive analysis and the analysis of variance, we formed a *locomotion* and an *object control* factor sum value as well as 2 age groups (70−84 months and 85−98 months).

On account of the multilevel structure (pupils from different schools), we calculated the interclass correlation coefficient (ICC) for the factor sum values to correlate the variance between the schools with the total variance.[15] We considered the dependencies within the multilevel structure in the models by correcting the standard error with the type = complex function for nested datasets implemented in Mplus.[16]

Missing values were estimated by the full information maximum likelihood algorithm implemented in Mplus. This allowed us to also consider data from pupils with individual missing values. Due to chance non-participation in individual test items, there were 1 to 5 missing values per test item (0.1%−0.5%). One school did not collect weight and height-data due to time constraints, and there were thus 48 missing BMI values (5%) in the data for that school.

A total of 3 consecutive models was calculated, each building on the last. Model 1 involved testing the factorial validity of the MOBAK-1 test instrument with the help of a confirmatory factor analysis. In Model 2, we then added the ability factor *speed strength* to Model 1 to test for discriminant validity. In Model 3, we added the dispositions sex, age, and BMI to the Model 1. In doing so, we treated all MOBAK test items as ordinal-scaled and accordingly applied the means and variance adjusted weighted least squares estimation. This makes it possible to conduct factor analyses and structural equation models with ordinal- and interval-scaled data.[17] The specifications of the 3 models are presented in the following:

2.3.1. Model 1

In calculating the confirmatory factor analysis, the 4 test items balancing, rolling, jumping, and side stepping were assigned to the factor *locomotion* and the 4 test items throwing, catching, bouncing, and dribbling to the factor *object control*. This assignment of the test items to the factors corresponds to the structure validated in a previous study.[11] Secondary loadings of the test items to the factor to which they were not assigned were not allowed. Factor loadings and residual variances were estimated freely for each test item.

2.3.2. Model 2

The latent factor *strength*, consisting of the test items 20 m sprint and standing long jump, was added to the confirmatory factor analysis of the MOBAK-1 test items as a covariate. This allowed to test the assumption that the motor ability *strength* is correlated with the basic motor competencies.[5] The residual variances of the latent MOBAK factors were allowed to intercorrelate.

2.3.3. Model 3

The dispositions age (to the month), sex, and BMI were added to Model 1 as covariates. The covariate BMI was set to correlate with the covariates age and sex.

The evaluation of the models' goodness-of-fit followed the fit indices suggested in the literature.[18,19] The following cut-offs indicate good model fit: $CFI > 0.95$, $RMSEA < 0.06$. Only standardized coefficients were reported due to the better interpretability of the results.

3. Results

Item difficulties of the MOBAK-1 test items may be inferred from the mean values shown in Table 1. Test items covered a wide range of difficulty levels and thus allowed a high degree of differentiation even in peripheral areas. In the total sample, balancing was the easiest test item at 1.68 ± 0.62, and jumping was the most difficult test item at 0.61 ± 0.78. The mean value in standing long jump was 96.41 ± 18.91, and the mean value in 20 m sprint was 4.97 ± 0.57.

The factor sum value for the factor *locomotion* was 4.48 ± 1.90 ($Md = 4.00$, $skewness = -0.151$, $kurtosis = -0.553$, $ICC = 0.067$), while that for the factor *object control* was 4.03 ± 2.07 ($Md = 4.00$, $skewness = -0.022$, $kurtosis = -0.897$, $ICC = 0.002$). According to the ICC values, around 7% of the total variance in the pupils' *locomotion* performances could be attributed to the school they attended, whereas we recorded no significance for *object control* performance.

In the *locomotion* sum value, there were no significant differences with regard to sex ($F = 1.39$, $p = 0.239$, $\eta^2 = 0.002$) or age group ($F = 0.16$, $p = 0.686$, $\eta^2 = 0.000$). There were no differences between sex and age group at the level of the individual locomotion items either. The only exception was the test item jumping, in which the girls performed significantly better ($F = 11.81$, $p = 0.001$, $\eta^2 = 0.013$).

In the *object control* sum value, the boys ($F = 132.00$, $p < 0.001$, $\eta^2 = 0.126$) and the older age group ($F = 37.47$, $p < 0.001$, $\eta^2 = 0.039$) showed significantly better performances. These differences were also visible at the level of the individual object control items.

On the *strength* test items 20 m sprint ($F = 22.57$, $p < 0.001$, $\eta^2 = 0.024$) and standing long jump ($F = 39.92$, $p < 0.001$, $\eta^2 = 0.042$), the boys performed significantly better than the girls. However, the older age group only performed significantly better on standing long jump ($F = 5.35$, $p = 0.021$, $\eta^2 = 0.006$). On *sprint*, there were no significant differences between the age groups ($F = 0.81$, $p = 0.369$, $\eta^2 = 0.001$).

There were weak negative correlations between *BMI* and the *locomotion* and *strength* test items ($r = -0.070$ to $r = -0.160$, Table 2). Children with a higher BMI performed worse on these test items. There were no connections between BMI and the *object control* test items, with the exception of a weak positive correlation between BMI and throwing ($r = 0.127$). The correlations between the test items for measuring basic motor competencies and the test items for measuring motor abilities were between $r = 0.095$ and $r = 0.308$. This may be taken as an indication for discriminant validity at the level of the test items.

In Model 1, the confirmatory factor analysis of the MOBAK-1 test items with the factors *locomotion* and *object control* resulted in a good model fit ($\chi^2 = 36.3$, $df = 19$, $p = 0.010$, $CFI = 0.97$, $RMSEA = 0.031$). The associatedfactor loadings were between

Table 1
Descriptive values of the MOBAK-1 test items (0−2), the MOBAK factor sum values (0−8), and the strength test items (mean ± SD).

Variable	Age		Sex		
	70−84 months ($n = 653$)	85−98 months ($n = 270$)	Boys ($n = 501$)	Girls ($n = 422$)	Total ($n = 923$)
Locomotion					
Balancing	1.68 ± 0.61	1.69 ± 0.62	1.70 ± 0.59	1.66 ± 0.64	1.68 ± 0.62
Rolling	1.14 ± 0.85	1.14 ± 0.86	1.12 ± 0.84	1.16 ± 0.86	1.14 ± 0.85
Jumping	0.62 ± 0.78	0.58 ± 0.76	0.53 ± 0.74	$0.71 \pm 0.81^{\#}$	0.61 ± 0.78
Side stepping	1.04 ± 0.86	1.03 ± 0.88	1.06 ± 0.86	1.02 ± 0.87	1.04 ± 0.86
Sum value	4.49 ± 1.88	4.44 ± 1.97	4.41 ± 1.83	4.56 ± 1.99	4.48 ± 1.90
Object control					
Throwing	0.68 ± 0.72	0.87 ± 0.73**	0.88 ± 0.75	$0.55 \pm 0.67^{\#}$	0.73 ± 0.73
Catching	1.34 ± 0.73	1.55 ± 0.67**	1.50 ± 0.69	$1.29 \pm 0.74^{\#}$	1.40 ± 0.72
Bouncing	0.77 ± 0.85	1.11 ± 0.86**	1.11 ± 0.86	$0.58 \pm 0.78^{\#}$	0.87 ± 0.86
Dribbling	0.99 ± 0.79	1.13 ± 0.83*	1.22 ± 0.79	$0.81 \pm 0.76^{\#}$	1.03 ± 0.80
Sum value	3.77 ± 2.01	4.67 ± 2.08**	4.71 ± 2.01	$3.24 \pm 1.85^{\#}$	4.03 ± 2.07
Strength					
20 m sprint (s)	4.98 ± 0.57	4.95 ± 0.56	4.89 ± 0.55	$5.07 \pm 0.58^{\#}$	4.97 ± 0.57
Standing long jump (cm)	95.53 ± 18.43	98.54 ± 19.89*	99.97 ± 19.34	$92.22 \pm 17.51^{\#}$	96.41 ± 18.91

* $p < 0.05$, ** $p < 0.001$, compared with younger group. # $p \leq 0.001$, compared with boys.
Abbreviation: MOBAK = Motorische Basiskompetenzen.

Table 2
Spearman rank correlations between the test items.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Object control										
(1) Throwing	—									
(2) Catching	0.234**	—								
(3) Bouncing	0.246**	0.328**	—							
(4) Dribbling	0.132**	0.211**	0.353**	—						
Locomotion										
(5) Balancing	0.048	0.149**	0.141**	0.103**	—					
(6) Rolling	0.071*	0.077*	0.091**	0.151**	0.180**	—				
(7) Jumping	0.075*	0.070*	0.132**	0.134**	0.180**	0.135**	—			
(8) Sidestepping	0.046	0.070*	0.156**	0.200**	0.205**	0.117**	0.207**	—		
Strength										
(9) 20 m sprint	0.138**	0.232**	0.308**	0.216**	0.238**	0.162**	0.095**	0.165**	—	
(10) Standing long jump	0.174**	0.173**	0.240**	0.133**	0.235**	0.159**	0.206**	0.112**	0.411**	—
(11) BMI	0.127**	0.062	−0.016	−0.049	−0.160**	−0.120**	−0.116**	−0.070*	−0.112**	−0.157**

* $p < 0.05$, ** $p < 0.01$.
Abbreviation: BMI = body mass index.

$\beta = 0.38$ and $\beta = 0.75$. The intercorrelation of the 2 resulting factors was $r = 0.54$ (Fig. 1). This result confirms the 2-factor structure postulated in the study by Herrmann et al.[11] Both latent factors achieved acceptable factor reliabilities (FR) (*object control*: FR = 0.67; *locomotion*: FR = 0.57).[20]

In Model 2, the latent factor *strength* was composed of the 2 test items 20 m sprint and standing long jump. This factor was integrated into the confirmatory factor analysis (Model 1) as a covariate with the factors *locomotion* and *object control*. Model 2 has a good model fit ($\chi^2 = 59.0$, $df = 32$, $p = 0.003$, $CFI = 0.97$, $RMSEA = 0.030$) and demonstrated that the test items on the 3 latent factors can be represented as clearly distinct from one another. The latent covariate *strength*—with the test items 20 m sprint ($\beta = 0.67$, $p < 0.001$) and standing long jump ($\beta = 0.62$, $p < 0.001$)—had a significant influence on the factor *locomotion* ($\beta = 0.67$) and the factor *object control* ($\beta = 0.62$, $p < 0.001$). Due to the cross-sectional design of our study, it may be assumed in theory that the effect works in this direction, but this should be regarded initially as a speculative assumption. The intercorrelation (of the error terms) of the 2 MOBAK factors was $r = 0.20$ ($p < 0.001$).

Model 3, in which the covariates age, sex, and BMI were added to Model 1 (Fig. 2), achieved a satisfactory model fit ($\chi^2 = 97.9$, $df = 38$, $p < 0.001$, $CFI = 0.90$, $RMSEA = 0.041$).

The connections between the covariates and the MOBAK factors *locomotion* and *object control* shown at a descriptive level (Table 1) and in the correlations between the test items (Table 2) also appeared at the level of the latent factors.

Whereas age, calculated to the month, had a positive influence ($\beta = 0.29$, $p < 0.001$) on the factor *object control*, age had no significant influence on the factor *locomotion*. The older the pupils were, the better were their *object control* performances.

With regard to the covariate sex (male = 0, female = 1), there was a (slightly) positive coefficient for *locomotion* ($\beta = 0.07$, $p = 0.020$) and a (moderately) negative coefficient for *object control* ($\beta = -0.44$, $p < 0.001$). The boys achieved better *object control* performances, whereas the girls achieved slightly better *locomotion* performances.

BMI had no influence on *object control* ($\beta = 0.02$, $p = 0.580$) but a (moderately) negative effect on *locomotion* ($\beta = -0.28$, $p < 0.001$). The higher the pupils' BMI was, the lower were their *locomotion* performances.

There was a weak correlation between age and BMI ($\beta = 0.10$, $p = 0.002$) but no correlation between sex and BMI ($\beta = -0.01$, $p = 0.750$). The intercorrelation (of the error terms) of the 2 MOBAK factors was $r = 0.70$ ($p < 0.001$) in this model.

4. Discussion

The validation study described in this article served to test the factorial and discriminant validity of the MOBAK-1 test instrument. The aim was to verify the existing results from

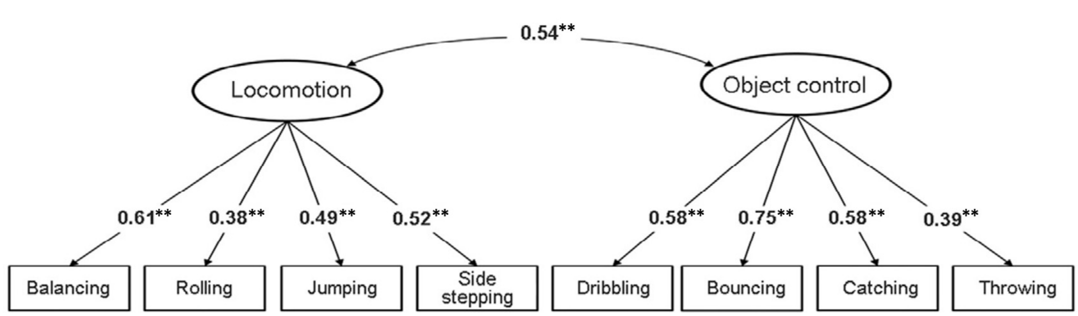

Fig. 1. Confirmatory factor analysis of the MOBAK-1 test items (Model 1). **$p < 0.01$. MOBAK = Motorische Basiskompetenzen.

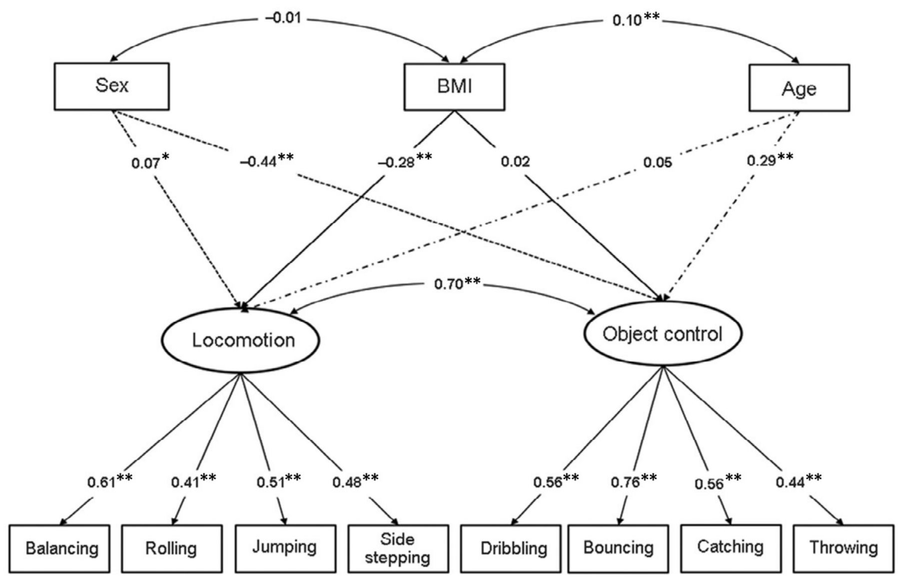

Fig. 2. Confirmatory factor analysis of the MOBAK-1 with the covariates sex, BMI, and age (Model 3). $*p < 0.05$; $**p < 0.01$. BMI = body mass index; MOBAK = Motorische Basiskompetenzen.

Herrmann et al.[5,11] on a second, larger sample. The confirmatory factor analysis confirmed the latent factors *locomotion* and *object control*. The respective factor sum values clearly differentiated the performances of the pupils in the sample without floor or ceiling effects. Previous studies[2,11,21] confirmed the postulated factorial validity in first, third, and fifth graders. For the assessments in the third and fifth grades of primary school, the MOBAK-3, and MOBAK-5 test instruments were used. These MOBAK test instruments were designed to measure the competency level specified in the curricula of the third and fifth grades. They are used to determine the competency level of pupils in a particular grade at the beginning of the school year and determine whether they improve during the following school year.

We tested for discriminant validity at the manifest level of the test items by means of correlations and at the level of the factors by means of confirmatory factor analyses with covariates. The correlations of the MOBAK test items with the *strength* test items were slight to moderate. At the latent level, the MOBAK test items formed 2 discrete latent factors on which the latent covariate *strength* had a moderate effect. As these results agree with the results of the previous study,[5] we consider the discriminant validity to be confirmed.

In the third model, the older pupils and the boys achieved better performances on the MOBAK factor *object control*. On the MOBAK factor *locomotion*, pupils with a higher BMI achieved worse performances and the girls achieved better performances than the boys.

Previous studies[2,5] investigated the link between *BMI* and basic motor competencies for the first and fifth grades and managed to demonstrate that BMI is negatively correlated with *locomotion* but shows no significant correlation with object movement in the first grade and a weak negative correlation in the fifth grade. Studies investigating motor skills report comparable results.[1,22] Recent research on the link between motor skills and BMI in children and adolescents reports weak to moderate negative correlations.[1] Okely and colleagues[23] demonstrated that motor skills are correlated negatively with BMI and hip measurement in a study with fourth to tenth graders. Whereas the correlation between BMI and *object-control* skills was less pronounced in this study, the correlation between BMI and *locomotor* skills was high. Such negative correlations are already present in preschool-aged children and increase in the course of primary school.[24] Lopes and colleagues[25] conducted a study with 6−14-year-old children demonstrating that motor coordination is also negatively correlated with BMI. This correlation was similarly pronounced in 6-year-old girls and boys. In older children (11 years), the authors found stronger correlations.

Three recently reported MOBAK studies,[2,5,11,21] show that gender is correlated with basic motor competencies in the first, third, and fifth grades. Generally, boys perform better in *object control*, whereas girls perform better in *locomotion*. Several studies indicate a correlation between gender and motor performance.[26,27] In the study by Barnett and colleagues,[26] for instance, the authors demonstrated that significantly more boys than girls achieve a high level of object control skills in childhood and adolescence. For locomotor skills, the authors did not find any significant differences, neither in children nor in adolescents. Furthermore, it has been shown that these gender-related differences increase along age cohorts.[27−29] Such differences are explained to be due to different opportunities for motor experiences,[30] and different parental and social expectations.[31]

In this context, the results obtained in a previous study[2] showed that the frequency and type of physical activity outside of school is correlated in a potentially predictive way with the basic motor competencies of fifth graders (10.50−11.50 years). In particular, correlations between frequency of individual sports (e.g., gymnastics, dancing, and track and field) and *locomotion*, and frequency of team sports (e.g., soccer, handball, and basketball) and *object control* were found. In the same study, it was also shown that girls are much more involved in individual sports and boys in team sports.

This test for validity resulted in a positive assessment of the psychometric characteristics of the MOBAK-1 test instrument. However, the study has several limitations. Basic motor competencies are assumed to be learnable, context-dependent, and functional. There is still no evidence that basic motor competencies can be developed (through learning), because all studies conducted so far have been cross-sectional in nature. The test for discriminant validity has, as yet, only been performed with a small number of test items based on abilities. To determine the relationship between different motor performance dispositions, it will be necessary to also conduct skills-oriented tests in the future (e.g., test of gross motor development (TGMD-2)[32]). Although the results of the study are based on a convenience sample, we suppose that the reported relations between age, gender, and BMI can be considered representative. Unfortunately, no further descriptive information about the life circumstances of the children was given (e. g., family background, migration, and special educational needs).

As the MOBAK-1 test instrument formulates age-specific tasks and is aligned with curricula designed for these age groups, it can only differentiate adequately between basic motor competencies for pupils in the first and second grades and with a limited age span of 6 to 8 years.

To achieve curricular validity at higher grade levels, it will therefore be necessary to adapt the difficulty of the tasks measured by the MOBAK-1 test instrument to reflect the curricular conditions at these grade levels.

On the whole, the MOBAK-1 test instrument developed for the study presented here measures a relevant selection of motor functions and makes it possible to conduct analyses of effects in sports and physical education classes within the context of subject-specific educational research.

5. Conclusion

The MOBAK approach presented in our validation study shows that the construct of basic motor competencies is pedagogically justified and based on competence theories, and that it differs from already existing motor performance dispositions (e.g., motor abilities). The MOBAK-1 test instrument allows a pedagogical diagnosis and evaluation of basic motor competencies in sport and physical education. Besides the achievement of individual test items (performances, e.g., jumping, throwing), the focus lies on the 2 underlying competencies *locomotion* and *object control*, which display a broader area of motor function. This new MOBAK approach is therefore theoretically and empirically distinct from familiar motor abilities and skills. Existing fundamental movement skill tests (e.g., TGMD-2,[32]) assess the quality of movement execution on individual test items (e.g., hip rotation in the overhead throw) but neglect the achievement of the movement goal. In contrast, the MOBAK test instrument focuses on the functional accomplishment of motor requirements and the achievement of the movement goal (e.g., actually hitting a target) by means of general basic motor competencies.

The MOBAK-1 test instrument is easy to administer for scientist and teachers. Standardization is guaranteed, because a manual including procedure and simple analyses is available online in 3 different languages (German,[33] English,[10] and French[34]). The measurement can easily be implemented in regular physical education lessons. An easy calculation of the sum scores *object control* and *locomotion* is provided. Moreover, the sum scores are meaningful to interpret and allow teachers to identify groups in need of special support and initiate special support measures to reduce potential deficits. Meanwhile there are on-going MOBAK-1 assessments across different European countries (e.g., Luxemburg, Switzerland, Czech Republic, Italy, Belgium, Lithuania, Austria, and Portugal).

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Authors' contributions

CH was responsible for the overall conception and design of this study, analyzed the data, and drafted the manuscript; CHEIM was responsible for the overall conception and design of this study, data collection and management, and revised the manuscript; HS contributed to the statistical analyses and the interpretation of the study results and revised the manuscript. All authors read and approved the final manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

References

1. Robinson LE, Stodden DF, Barnett LM, Lopes VP, Logan SW, Rodrigues LP, et al. Motor competence and its effect on positive developmental trajectories of health. *Sports Med* 2015;**45**:1273–84.
2. Herrmann C, Seelig H. Construct validity of the MOBAK-5 test instrument and determinants of basic motor competencies of fifth graders. *German J Exerc Sport Res* 2017;**48**: doi:10.1007/s12662-016-0430-3.
3. Stodden D, Langendorfer S, Roberton MA. The association between motor skill competence and physical fitness in young adults. *Res Q Exerc Sport* 2009;**80**:223–9.
4. Weinert FE. Concept of competence: a conceptual clarification. In: Rychen DS, Salganik LH, editors. *Defining and selecting key competencies*. Ashland, OH: Hogrefe & Huber; 2001.p.45–65.
5. Herrmann C, Gerlach E, Seelig H. Basic motor competences in primary school. Rationale, assessment and empirical testing of a measurement instrument. (Motorische Basiskompetenzen in der Grundschule: Begründung, Erfassung und empirische Überprüfung eines Messinstruments). *Sportwiss* 2016;**46**:60–73. [in German].
6. Kurz D, Fritz T, Tscherpel R. Der MOBAQ-Ansatz als Konzept für Mindeststandards für den Sportunterricht? (Using the MOBAQ approach as a concept for minimum standards for physical education). In: Oesterhelt V, Hofmann J, Schimanski M, Scholz M, Altenberger H, editors. *Sportpädagogik im Spannungsfeld gesellschaftlicher Erwartungen,*

wissenschaftlicher Ansprüche und empirischer Befunde. Hamburg: Czwalina; 2008.p.97–106. [in German].

7. Seefeldt V. Developmental motor patterns: implications for elementary school physical education. In: Nadeau C, Holliwell W, Newell K, Roberts G, editors. *Psychology of motor behavior and sport*. Champaign, IL: Human Kinetics; 1980.p.314–23.
8. Whitehead M. *Physical literacy: throughout the lifecourse*. London and New York: Routledge; 2010.
9. Klieme E, Avenarius H, Blum W, Döbrich P, Gruber H, Prenzel M, et al. *The development of national educational standards. Expertise. (Zur Entwicklung nationaler Bildungsstandards: expertise)*. Frankfurt am Main: Deutsches Institut für Internationale Pädagogische Forschung; 2003.
10. Herrmann C, Seelig H. *MOBAK-1: basic motor competencies in first grade: testmanual*. Available at: http://www.dsbg4public.ch/custom/upload/docs/bx7gklezunvcv4ziuklmf6446rw60cb1251g.pdf; 2014. [accessed 01.02.2015].
11. Herrmann C, Gerlach E, Seelig H. Development and validation of a test instrument for the assessment of basic motor competencies in primary school. *Meas Phys Educ Exerc Sci* 2015;**19**:80–90.
12. EUROFIT. *Handbook for the EUROFIT tests of physical fitness*. 2nd ed. Strasbourg: Sports Division Strasbourg; 1993.
13. Bös K, Wohlmann R. AST 6−11 General motor skills test for children aged 6 to 11 years. (AST 6−11 Allgemeiner Sportmotorischer Test für Kinder von 6 bis 11 Jahren). *Haltung Bewegung* 2000;**20**:5–16. [in German].
14. Muthén LK, Muthén BO. *Mplus user's guide: statistical analysis with latent variables*. 7th ed. Los Angeles, CA: Muthén & Muthén; 2012.
15. Raudenbush SW, Bryk AS. *Hierarchical linear models: applications and data analysis methods*. 2nd ed. Thousand Oaks: Sage Publications; 2002.
16. Muthén BO, Satorra A. Complex sample data in structural equation modeling. *Sociol Methodol* 1995;**25**:267–316.
17. Muthén BO, du Toit SHC, Spisic D. *Robust inference using weighted least squares and quadratic estimating equations in latent variable modeling with categorical and continuous outcomes*. Unpublished technical report. Los Angeles, CA: University of California; 1997.
18. Schermelleh-Engel K, Moosbrugger H, Müller H. Evaluating the fit of structural equation models: tests of significance and descriptive goodness-of-fit measures. *Methods Psychol Res Online* 2003;**8**:23–74.
19. Schreiber JB, Stage FK, King J, Nora A, Barlow EA. Reporting structural equation modeling and confirmatory factor analysis results: a review. *J Educ Res* 2006;**99**:323–38.
20. Weiber R, Mühlhaus D. *Structural equation modelling (Strukturgleichungsmodellierung)*. 2nd ed. Berlin: Springer Gabler; 2014.
21. Herrmann C, Seelig H. Structure and profiles of basic motor competencies in the third grade-Validation of the test instrument MOBAK-3. *Percept Mot Skills* 2017;**124**:5–20.
22. Barnett LM, Lai SK, Veldman SL, Hardy LL, Cliff DP, Morgan PJ, et al. Correlates of gross motor competence in children and adolescents: a systematic review and meta-analysis. *Sports Med* 2016;**46**:1663–88.
23. Okely AD, Booth ML, Chey T. Relationships between body composition and fundamental movement skills among children and adolescents. *Res Q Exerc Sport* 2004;**75**:238–47.
24. Spessato BC, Gabbard C, Robinson L, Valentini NC. Body mass index, perceived and actual physical competence: the relationship among young children. *Child Care Health Dev* 2013;**39**:845–50.
25. Lopes VP, Stodden DF, Bianchi MM, Maia JAR, Rodrigues LP. Correlation between BMI and motor coordination in children. *J Sci Med Sport* 2012;**15**:38–43.
26. Barnett LM, van Beurden E, Morgan PJ, Brooks LO, Beard JR. Gender differences in motor skill proficiency from childhood to adolescence. *Res Q Exerc Sport* 2010;**81**:162–70.
27. Ikeda T, Aoyagi O. Relationships between gender difference in motor performance and age, movement skills and physical fitness among 3- to 6-year-old japanese children based on effect size calculated by meta-analysis. *Sch Health* 2009;**5**:9–23.
28. Chen W, Mason S, Hypnar A, Bennett A. Assessing motor skill competency in elementary school students: a three-year study. *J Sports Sci Med* 2016;**15**:102–10.
29. Saraiva L, Rodrigues LP, Cordovil R, Barreiros J. Influence of age, sex and somatic variables on the motor performance of pre-school children. *Ann Hum Biol* 2013;**40**:444–50.
30. Barnett LM, van Beurden E, Morgan PJ, Brooks LO, Beard JR. Childhood motor skill proficiency as a predictor of adolescent physical activity. *J Adolesc Health* 2009;**44**:252–9.
31. Cools W, De Martelaer K, Samaey C, Andries C. Fundamental movement skill performance of preschool children in relation to family context. *J Sports Sci* 2011;**29**:649–60.
32. Ulrich D, Sanford C. *Test of gross motor development*. 2nd ed. Austin, TX: PRO-ED; 2000.
33. Herrmann C, Seelig H. *Basic motor competencies in first grade: testmanual. (MOBAK-1: motorische Basiskompetenzen in der 1. Klasse: testmanual)*. Available at: http://edoc.unibas.ch/dok/A6298846; 2014. [accessed 26.08.2014]. [in German].
34. Herrmann C, Seelig H. *MOBAK-1: compétences motrices de base en première année primaire. Manuel de test*. Available at: http://www.dsbg4public.ch/custom/upload/docs/6lw7wasar57jknhofy1zt2c33mqo2b41254g.pdf; 2015. [accessed 24.10.2015]. [in French].