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Original Article

Development of basic motor competencies among standard population during the prepubertal period

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Abstract
A multidimensional approach to children's physical literacy encompasses four interrelated areas: physical fitness, basic motor skills, daily physical activity, and psycho-social/cognitive factors. The basic goal of physical and sports education in primary education is to maintain physical literacy and to develop motor competencies of younger school age children. These significantly affect the deficiency of physical activity in the daily routine of children, which proves to be one of the most serious health risk factors. Physical activity of children should be stimulated at a younger school age in which they should engage in adequate physical activity for at least 60 minutes a day.The aim of this study was to determine the motor learning of 6- and 7-year olds, to diagnose the level of their basic motor competencies and to develop them under the conditions of physical and sports education in schools. We assumed a significant positive impact on the level of motor competencies. The experiment was attended by 84 pupils in the first year of primary school in Presov (Slovakia). The level of motor competencies was assessed using the MOBAK 1 test battery before and after application of an exercise program. The program included physical exercises, activities with non-traditional equipment and psychomotor games. The intervention lasted 6 months. A parametric t-test for independent samples, F-test to compare variances, correlation coefficient, and effect size were used to compare the results of our study. All tests were performed at $\alpha = 0.01$ or $\alpha = 0.05$. The statistical significance of the differences in the level of movement competencies between experimental and control groups after the intervention was confirmed. Gender differences were not confirmed. We conclude that intentional stimulation of psychomotor development and intervention in the motor competencies, which takes into account the developmental acceleration, has a positive effect on the tempo and quality of motor learning. This study was supported by the Scientific Grant Agency of the Ministry of Education, Science, Research, and Sport of the Slovak Republic and the Slovak Academy of Sciences under Grant VEGA 1/0573/18*Movement correction of problematic behavior of pupils in a typical population and pupils with special educational needs who were educated in integrated conditions*.
KeyWords*:* **physical literacy, MOBAK 1 test instrument, intervention program, children**

Introduction

The cultivation of a child's personality is a priority objective of the educational processes of contemporary primary education, which is a dynamic open system of forming the foundations of literacy, in the spirit of the lifelong learning process. Recently, a review of didactic concepts and practices showed that curricular continuity, adequate content, and performance standards are the most important. The personality of the pupil, his competence, self-realization, and responsibility in adopting a healthy lifestyle are at the forefront. The physically active lifestyle of the population presupposes the long-term systematic development and application of physical literacy. Physical literacy is a part of the ontogenetic development of the individual. Each stage is characterized by its specific characteristics, structure and course. A physically literate person should have adequate motor abilities, skills, and knowledge, including a positive attitude to physical activities, and is able to take responsibility for his own health. Physical literacy including motor competence is becoming an essential part of the standards of physical and sports education in schools and should also play a role in promoting public health (Mathisen, 2016; Schembri et al., 2019; Scheuer, Bund, & Herrmann, 2019; Sgro et al., 2019; Whitehead et al., 2018).

In recent years, the concept of physical literacy has received increased attention among researchers in physical education, sports, and physical activity. The term physical literacy dates back as early as the 1990s, but did not receive sufficient attention then. The philosophical concept was subsequently elaborated on and published by Whitehead et al. (2018), followed by researchers from the predominantly Anglo-Saxon region(Allan, Turnidge, &Cõte,2017; Ennis, 2015; Herrmann&Seelig, 2017; Robinson et al., 2015;Sallen et al., 2020) or from the Czech Republic (Vašíčková, 2016).Whitehead et al. (2018)defined physical literacy as having

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the motivation, knowledge and ability to keep physical activity at an adequate and appropriate level throughout life. An individual who is able to perform movement economically, even in difficult situations of exercise discomfort without coordination problems, may be considered a physically literate person. According to the International Physical Literacy Association (IPLA), physical literacy can be described as the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life.

There are certain attributes underlying the conceptual model of physical literacy. Physical literacy is a universal concept applicable to the individual's lifestyle. The process of developingphysical literacy is influenced by a number of characteristics and processes, such as motivation, self-confidence, motor competencies, interaction with the environment, creativity, various movement strategies and ability to choose within the framework of an active lifestyle (Cairney et al., 2019; Dugas, 2017; Sallen et al., 2020; Vašíčková, 2016). If an individual has the motivation to engage in physical activity, then self-efficacy and self-confidence will increase, as motor competencies will also improve. As reported by Dudley (2015), the conceptual model of physical literacy contains four core elements:1) movement competencies,2) rules, tactics, and strategies of movement,3) motivation and behavioral skills of movement, and 4) personal and social attributes of movement.

Dudley (2015) referred to fundamental movement skills as the "bank of movement competencies". The more skills individuals have in their bank, the more they will be able to respond to situations in a way that is automatic and meaningful to them. A physically literate person should be able to perform exercises correctly and move effectively with the motivation to be physically active and create new ways of solving movement situations. Dudley'sattributes of the conceptual model of physical literacy include the strategy of movement, behavioral skills of movement, and social elements of movement, and it takes into account personal motivation and attitude of an individual towards the satisfaction of his or her physiological need to be physical active.

The domain of motor competencies is also important in physical and sports education. Motor competence refers to the ability of a person to mobilize and activate acquired skills, knowledge, and attitudes in real life,and to apply them effectively during an activity. Motor competencies are defined as motor performance dispositions (Scheuer, Herrmann, & Bund, 2019). They can be learned and improved using previous experience. Motor competence is a broader term because it involves a number of partial motor skills based on the level of motor ability. Motor competence is closely linked to a positive relationship to physical activity and knowledge of it and a healthy lifestyle. The development of motor competencies is strongly influenced by the culture of the given society. When dealing with challenging situations in a new environment, new motor skills are created, complementing the existing competence pool.

Recently, the focus of physical and sports education has significantly shifted from performance-oriented teaching towards physical literacy and the development of motor competences of pupils. The aim is to create a permanent interest in physical activity and sport as a part of a healthy lifestyle based on the individual needs of pupils (Sigmundsson et al., 2017). The main aim of physical education and sport during prepuberty is to develop physical literacy through various physical activities, to create a positive attitude of children toward movement and to strengthen their health. According to the latest knowledge (Scheuer et al., 2017; Šimonek, 2018), when selecting and assessing the talents of children, we should not only monitor the level of motor abilities but the level of their motor skills. According to Šimonek (2018), basic motor skills are motor performance dispositions, which are the minimum standards that enable children to participate in physical culture.

One relevant tool for the assessment of motor competencies is the MOBAK 1 test battery, which consists of eight test items (Scheuer, Herrmann, & Bund, 2019). These test items measure eight basic motor qualifications which can be assigned to the two basic motor competencies of object control (movement with object-equipment) and locomotion (self-movement). The basic motor competency of object control involves the basic motor qualifications of throwing, catching, bouncing, and dribbling. The basic motor competency of locomotion involves the basic motor qualifications of balancing, rolling, jumping, and side stepping.

The role of physical teachers is to implement quality physical education curricula, extracurricular activities and health promotion programs, which are opportunities to develop pupils' motor abilities, skills, and basic motor competencies. Diverse physical activities should not discourage even less gifted pupils from moving. Well-prepared physical and sports lessons are a means of systematically developing pupils' competencies and exploiting their motor potential.

Our aim was to assess the current levels of basic motor competencies of prepubertal children in terms of their structure and intersexual differences. We also aimed to apply an intervention program to stimulate motor competencies and determine the effects on the attributes of the children's physical literacy. We hypothesized that there would be intersexual differences in the structure of children's competencies and a positive effect of the intervention program on the level of motor competencies and motor learning process of children included in the experimental group.

Material & methods

Participants

The study was conducted between September 2018 and May 2019 at an elementary school in the city of Presov. The participants included 84 children who attended 1st grade at elementary school. The average age of

the children was 6.75 ±0.40 years (boys: 6.82 ±0.42; girls: 6.68 ±0.38). The children included in the experimental (EG) or control group (CG) were selected randomly with the option tochoose whether or not to participate in the research. The research involved no risk of violating ethical principles.

Test protocol

The levels of motor competencies were assessed using the MOBAK 1 test battery (Herrmann&Seelig, 2014) before and after application of the intervention program. Testing sessions took place during physical and sports classes; the children were divided into small groups, and their performances were evaluated by three evaluators. We subsequently conducted a two-group parallel experiment in natural conditions of the physical education process. In the experimental group, an intervention program for the development of basic movement competencies was applied in 20 classes of physical and sports education in the first grade of primary school. The experimental factor in our study was the design of an intervention exercise program of psychomotor stimulation and motor competencies development based on the use of various physical exercises and movement games that were performed by children from the experimental group during a six-month period (30 exercise units). The activities were supervised by the physical education teachers, who were properly instructed about the movement program. The intervention program contained 30 physical exercises and activities with non-traditional equipment and psychomotor games. We followed the organization and teaching progression requirements to ensure an optimal effect of the exercise program among theschool-aged children. To achieve the highest efficiency of exercise during thephysical education classes, we implemented short blocks of physical exercises and psychomotor games. Each teaching unit included 6 physical activities or movement games that children played for 10-12 min: during the introductory section and in the final section of the class. The children assigned to the control group did not participate in any physical activities and only attended standard physical education classes twice a week for 6 months.

Statistical analysis

To process the data on motor parameters, we used arithmetic mean as a measure of central tendency and standard deviation as a measure of variation. To assess the normality of distribution of data collected, we used the Shapiro-Wilk test. The parametric paired t-test for independent samples and F-test and effect size was used to process the collected data and to assess significant differences between groups in the MOBAK 1 test. Correlations were determined using the Pearson's correlation coefficient. The Faculty of Sports at the University of Presov approved this study. All legal representatives of the participants provided their written consent and were made aware that there would be no financial cost or incentive for participation at the time of enrolling in the study.

Results

The differences in the MOBAK 1 test items, including both the "Object control" and "Locomotion" factors, are shown in Tables 1 and 2.The motor parameters show the baseline levels of motor competencies for both groups before and after the experiment.

Table 1.Differences between the experimental and control groups before intervention

MOBAK 1		V_{EG}	V_{CG}	F	t	Statistical significance
		M ± SD	***M ± SD***			
Pretest	Object control	2.40 ± 1.56	2.54 ± 1.62	1.071	0.417	-
	Locomotion	3.00 ± 1.32	2.93 ± 1.75	1.771	0.199	-
	Σ	5.40 ± 2.03	5.47 ± 2.37	1.363	0.159	-

Note.Σ - sum value, x - arithmetic mean, SD - standard deviation, F - test, t - parametric test for independent samples, V_{EG} - experimental group, V_{CG}*- control group*

At the beginning of the experiment, 6- to 7-year-old children from the experimental group (V_{EG}) and from the control group (V_{CG}) showed almost identical levels of motor competencies. Upon completion of the 6-month intervention based on psychomotor exercises and games, all the motor competencies of the children from the experimental group (V_{EG}) (x = 11.95; SD = 2.09; t = 8.876; F = 1.684) improved. We found significant improvements in *object control* (x = 6.05; SD = 1.52; t = 7.622; F = 1.470) and *locomotion* (x = 5.90; SD = 1.03; t = 6.452; F = 2.419). The changes in the competencies of *object control and locomotion* were statistically significant at $p< 0.01$.

Table 2.Differences between the experimental and control groups after intervention

MOBAK 1		V_{EG}	V_{CG}	F	t	Statistical significance
		M ± SD	***M ± SD***			
Posttest	Object control	6.05 ± 1.52	3.23 ± 1.84	1.470	7.622	*p < 0.01*
	Locomotion	5.90 ± 1.03	3.97 ± 1.60	2.419	6.452	*p < 0.01*
	Σ	11.95 ± 2.09	7.20 ± 2.72	1.684	8.876	*p < 0.01*

Note. Σ -sum value, x - arithmetic mean, SD - standard deviation, F - test, t - parametric test for independent samples,V_{EG} - experimental group, V_{CG}*- control group*

Another way to identify the relationships and associations among the variables measured is the use of correlation analysis. This procedure enabled us to quantify the degree to which particular test items (T1 – T8) affected the MOBAK 1 sum value.Table 3 contains the correlations between scores for particular test items and the MOBAK 1-2 total score of V_{EG}.

Table 3. Correlations between the sum value MOBAK 1 test and test items

MOBAK 1	F1				F2			
	T1	T2	T3	T4	T5	T6	T7	T8
Pretest	0.50	0.52	**0.66**	0.62	0.60	0.58	0.46	0.11
Posttest	**0.67**	0.61	**0.77**	0.53	0.40	**0.64**	**0.67**	0.29

Note. F1 - Object control, F2 - Locomotion – MOBAK 1 factors, T1 - throwing, T2 - catching, T3 - bouncing, T4 - dribbling, T5 - balancing, T6 -rolling, T7 - jumping, T8 - side stepping, Pearson's correlation coefficients, significanceof p <0.01

According to the correlation analysis following the completion of the experiment, Table 3 shows a moderate degree of correlation between F1 -*throwing* (r_p= 0.67) and *bouncing* (r_p = 0.77). Additionally, moderate correlations were found between the F2 factor items, especially between *rolling* (r_p = 0.64) and *jumping* (r_p = 0.67). Weak to moderate correlations were found for*side stepping* (rp = 0.29), which requires complexity and smoothness of movement.

Tables 4 and 5 show gender differences in the levels of motor competencies between V_{EG} and V_{CG}. At the beginning of the experiment, there were no significant differences between boys and girls from the experimental group, which remained unchanged following the completion of the experiment. In the control group, there were significant differences in the items of object control (t = 2.572; ES = 0.78). Upon the completionof theexperiment, themotor competencies of boys from the control group significantly improved (t = 2.036; ES = 0.62).

Table 4. MOBAK 1 – gender differences in the experimental group($\mathbf{V_{EG}}$) before and after intervention

MOBAK 1		Boys (n=18) x ± SD	Girls (n=22) x ± SD	t	Sign.	ES
pretest	Object control	2.83 ± 1.54	2.04 ± 1.52	1.615	-	0.52
	Locomotion	2.55 ± 1.29	3.36 ± 1.25	1.998	-	0.64
	Σ	5.38 ± 2.35	5.40 ± 1.79	0.031	-	0.01
posttest	Object control	6.11 ± 1.13	6.00 ± 1.79	0.227	-	0.08
	Locomotion	5.72 ± 1.22	6.04 ± 0.84	0.984	-	0.31
	Σ	11.83± 2.02	12.04 ± 2.19	0.314	-	0.10

Note. Σ - sum value, x - arithmetic mean, SD - standard deviation, n - sample size, t-test for independent samples, Sign. - significance, ES - effect size

There were statistically significant differences between the boys in terms of V_{EG} and V_{CG} (F1 = 4.543; F2 = 4.025; sum value = 5.216) and girls (F1 = 6.436; F2 = 4.993; sum value = 7.333) after the completion of the experiment (see Table 6). The stimulation based on psychomotor exercises and games had a significant effect on the MOBAK 1 test scores of both boys and girls from the experimental group - V_{EG}.

Table 5.MOBAK 1 – gender differences in thecontrol group($\mathbf{V_{CG}}$) before and after intervention

MOBAK 1		Boys (n=22) x ± SD	Girls (n=22) x ± SD	t	Sign.	ES
pretest	Object control	3.13 ± 1.69	1.95 ± 1.32	2.572	*p < 0.05*	0.78
	Locomotion	2.95 ± 1.83	2.90 ± 1.71	0.084	-	0.03
	Σ	6.09 ± 2.54	4.86 ± 2.07	1.753	-	0.53
posttest	Object control	3.77 ± 1.92	2.68 ± 1.61	2.036	*p < 0.05*	0.62
	Locomotion	3.86 ± 1.61	4.09 ± 1.63	0.464	-	0.14
	Σ	7.63 ± 2.87	6.77 ± 2.56	1.052	-	0.32

Note.Σ - sum value, x - arithmetic mean, SD - standard deviation, n - sample size, t-test for independent samples, Sign. - significance, ES - effect size

Table 6. Changes in basic motor competencies: boys and girls $V_{ES} \rightarrow V_{CS}$

MOBAK 1	Pretest			Posttest		
	F1	F2	Σ	F1	F2	Σ
Boys $V_{EG} \rightarrow V_{CG}$	0.584	0.776	0.897	4.543	4.025	5.216
Statistical significance	-	-	-	*p < 0.01*	*p < 0.01*	*p < 0.01*
Girls $V_{EG} \rightarrow V_{CG}$	0.211	1.002	0.933	6.436	4.993	7.333
Statistical significance	-	-	-	*p < 0.01*	*p < 0.01*	*p < 0.01*

Note. F1 - Object control, F2 - Locomotion - MOBAK 1, Σ - sum value, numbers present values from the t-test for independent samples

Discussion

We aimed to assess the current levels of physical literacy of prepubertal children who have various levels of motor learning. The data showed that both the experimental and control groups showed identical levels of motor competencies before the experiment. Pupils enter first grade of elementary school upon completion of compulsory preschool education. Long-term intervention based on psychomotor exercises, games, and physical activities with nontraditional equipment resulted in an improvement of all basic characteristics, *object movement* and *locomotion*. The changes in the observed parameters were determined at the 5% significance level. Physical literacy that is manifested through the level of basic motor competencies corresponds to the qualitative level obtained by motor and knowledge learning. The results of primary school pupils were determined by the process of motor learning and significant environmental effect. Regarding the motor competencies, the children from the general population were exposed to an optimal amount of movement stimuli. There were no significant differences in the levels of motor competencies recorded in the control group that did not undergo any intervention.

The changes in the internal structure of basic motor competencies from the viewpoint of gender differences were determined as well. There was a statistically significant improvement in the competencies of Object control in bouncing a ball and dribbling a ball in the sample of boys, which agrees withŠimonek's research (Šimonek, 2018). Ball handling is a spontaneous activity that is popular with boys. The limiting prerequisite is adequate development of coordination abilities (spatial orientation, kinesthetic differentiation, reaction speed, rhythm, and balance). Several MOBAK 1 studies (Herrmann, Heim, & Seelig, 2019; Scheuer et al., 2017)have shown that gender is correlated with basic motor competencies in the first grade. Boys perform better in F1 *object control,* whereas girls perform better in F2 *locomotion.* It has been shown that these gender-related differences increase along age cohorts. Such differences are explained by the different opportunities for motor experiences and parental and social expectations (Quitério et al., 2018). Girls have a higher degree of responsibility and concentration, when completing tasks. Most of the boys wanted to perform the test items too spontaneous and quickly.

The most challenging test items was T7 jumping and T8 side stepping, which require a good level of kinesthetic differentiation, reaction ability and orientation. Thus, our assumption about the differentiated structure of basic motoric competencies is correct. We noticed gender differences in thelevels despite the similarity in the partial structure of motor skills and physical development. There were significant differences in the levels of basic motor competencies among the prepubertal pupils, which showed higher levels of object movement among boys and self-body movement among girls. When the motor competency of self-body movement was tested, children found jumping very difficult. They were not able to combine acceleration with rhythm of movement.

Motor competence development is an essential aim of physical education (PE) (Herrmann, Heim, & Seelig, 2019; Quitérioet al., 2018; Utesch et al., 2019). For example, children with limited developmental abilities in motor competence (e.g., running, catching) are likely have more difficulties with complex motor skills. Quality PE has been argued to be a critical determinant of motor competencies because it provides significant quality opportunities for all children. We wanted to answer the question of "which competencies a child should exhibit at a certain age to be able to participate in PE as well as sport?" Valid and adequate assessment strategies should be an important for PE teachers to determine motor competence development.

At the beginning of the experiment, 6- to seven-year-old children from the experimental group and control group showed almost identical levels of motor competencies. Upon completion of the 6-month intervention based on psychomotor exercises and games, all motor competencies of the children from the experimental group ($V_{EG)}$ improved. We found significant improvements in *object control* and *locomotion*. The changes in the competencies of *object control and locomotion* were statistically significant at $p< 0.05$.

Upon completion of the intervention program, boys and girls assigned to the V_{EG} showed improvements in all motor competencies compared with those the V_{CG}.

Physical literacy manifests itself through the levels of basic motor competencies, corresponding to the qualitative level of the child's motor learning. Targeted stimulation of motor skills may significantly affect functional performance characteristics, which determine the child's psychomotor development (Herrmann, Gerlach, &Seelig, 2015; Herrmann, Heim, &Seelig, 2019). In this context, the results showed that the frequency and type of physical activity outside of school is correlated in a potentially predictive way with the basic motor competences of pupils. Correlations between frequency of individual sports (e.g., gymnastics, dancing) and F2 locomotion, and frequency of team sports (e.g., soccer, basketball) and F1 object control were found (Herrmann, Gerlach, &Seelig, 2015). We agree with the view that children at this age should engage in all-around physical activities and should enjoy movement based on game. By having them play psychomotor movement games, we wanted to develop motor competences in the prepubertal children. When designing our intervention exercise program, we took into consideration the scientific findings of other authors (Lenková, et al., 2016; Robinson et al., 2015; Vašíčková, 2016). The children felt more self-confident and improved their academic and social skills.These facts confirm our hypothesis regarding the possibilities of targeted development and acquisition of basic motor competencies in the teaching process of physical and sports education among the general population at primary schools.

Conclusions

The results of our qualitative analysis of the level of basic motor competencies and their changes within our study contributed to determination of the structure and relationships between the variables studied for identifying the physical literacy of 6- and 7-year-old children.

Based on the results of our study, we formulated the following recommendations:

- to develop motor competences by applying a psychomotor games-based intervention program
- to incorporate psychomotor movement games into the introductory warm-up, preparatory, and final section of the PE class
- to place emphasis on the precision of movement execution exercises, and
- to monitor the motor competences levels by MOBAK test instruments

We share the views of the scientific community that physical literacy is a relevant concept that involves physical activity and movement throughout life. The specific nature of literacy can affect the individual age, talent, motor abilities, challenges and opportunities of the culture in which an individual lives. Everyone has the opportunity to develop and improve their physical literacy and profit from the growth of its potential.

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