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MOTOR EFFICIENCY IN RELATION TO BODY WEIGHT STATUS AND GENDER IN PRESCHOOL CHILDREN

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Abstract/Izvleček
Deficits in motor skills and function are associated with overweight and obesity in children. This study aimed to investigate the development of motor efficiency in 3-4-year-old children over seven months and to identify possible gender and body weight status differences in motor efficiency. In the study, there were 45 children (21 girls, 24 boys), the mean age of whom was 39 months. Analysis of the results of testing for differences in motor efficiency according to body weight status and movement components showed no statistically significant differences (p>0.05) between healthy weight and overweight children.

Keywords:
motor efficiency, motor abilities, body weight status, preschool child.

Motorična učinkovitost v povezavi s statusom telesne teže in spolom predšolskih otrok

Primanjkljaji motoričnih spretnosti in funkcij so povezani tudi s prekomerno težo in debelostjo pri otrocih. Namen raziskave je bil raziskati razvoj motorične učinkovitosti 3-4 leta starih otrok v sedemmesečnem obdobju in ugotoviti morebitne razlike v motorični učinkovitosti med spoloma in glede na status telesne teže. V raziskavi je sodelovalo 45 otrok (21 deklic, 24 dečkov), povprečna starost otrok je bila 39 mesecev. Analiza rezultatov testiranja razlik v motorični učinkovitosti glede na status telesne teže in komponento gibanja ni pokazala statistično značilnih razlik (p>0,05) med otroci z normalno telesno težo in otroci s prekomerno telesno težo.

Ključne besede:
motorična učinkovitost, motorične sposobnosti, status telesne teže, predšolski otrok.

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Introduction

Motor development is among the most essential forms and functions of psycho-physical development, starting before birth and continuing throughout life. Human motor development is particularly noticeable in the first three years of life, as the child achieves motor capacities beyond the reach of any other being in the first two years. This is also reflected in the ability to walk upright. From a completely helpless new-born, unable to move their body and grasp even the most fundamental objects, the child rapidly progresses to a stage where they can independently cover distances in space and manipulate objects at will (Videmšek et al., 2003).

The development of children's motor abilities from infancy to the end of preschool is exceptionally rapid, with children making giant developmental leaps in both the range and quality of their movement patterns in just six years. This leap includes both motor development and the child's physical, cognitive, emotional, and social development. This rapid development in a relatively short period makes it paramount to consider the principle of appropriateness when planning sports and education programs, which requires that content, format, and work methods be adapted to the child's biological age. In addition, it is essential to consider the principle of acceleration or anticipation, which means that when choosing physical activities, we must anticipate to some extent the child's developmental abilities (Videmšek and Visinski, 2001).

Children's physical activity/sports participation, especially in the pre-school and early school years, is undoubtedly a reasonable basis for later involvement in more complex sporting activities. Appropriate activities strongly influence the child's motor, social, and emotional development, as well as the development of some cognitive processes. The golden age for motor learning is increasingly moving from early childhood. The minimal presence or complete absence of physical/sporting activities in the education of the growing child in later years cannot be fully compensated for, as their impact on the progression of growth, perception, and maturation is diminishing. Therefore, during this period, we must ensure the optimal development of motor abilities and the systematic transmission of fundamental motor skills. Activities should meet the child's daily need for movement, play, relaxation, and socializing, and at the same time, impact the child's health (Dekleva et al., 2017).

Systematic, integrated, engaging, and imaginative sports and movement activities based on expert and scientific knowledge are key to children's optimal motor development. Only in this way can children develop their motor and functional abilities (Šimunič et al., 2010).

In the early years of a child's life, the focus is on motor development, which develops from simple to complex forms of movement, from essential elements to more complex sporting activities later in life. If a child does not acquire these motor skills at the right time, it is very difficult for them to compensate for these later on, or if they fail to develop at all (Videmšek and Jovan, 2002).

After about two years of life, a period of active involvement in various physical activities and experimentation with the movement of one's own body begins. On their own or with the influence of their environment, children discover and develop the many motor skills and abilities they need for different types of movement. During activity, their balance improves, and their movements become more coordinated and rhythmic. Typically, by 3-4 years, they have mastered a series of movement patterns, mainly natural movements such as running, jumping, throwing an object, and catching a ball. They can also stand and move on one leg (Škof, 2007).

A 3-year-old engages in group games, which should be simple and not too complicated. The activities should be varied, as a child of this age quickly loses concentration and interest. From the age of five onwards, they want to play independently in group play. An adult is no longer necessary to be in charge of the game, but can assume the role of coordinator and observer. Concentration on the task at hand increases, and the child remembers more and more accurately (Videmšek et al., 2018)

During the preschool years, between the ages of 3 and 6, a child's motor development accelerates dramatically. Movement becomes not only more skilful but also more efficient and economical. Through appropriate activities, the child develops not only motor and functional skills but also cognitive, emotional, and social skills (Videmšek and Visinski, 2001).

During the preschool years, children can acquire a wide range of movement experiences crucial for later motor development. The foundations for more advanced movement patterns are being formed during this period, so it is extremely important that children have a quality experience.

These foundations significantly impact the child's motor development, subsequent participation in numerous sporting activities, and quality of life across their lifespan (Marjanovič Umek, 2010).

For some children, kindergarten is the only stimulating environment for motor development. Every preschool teacher's task is to promote children's development by teaching and planning content through activities. Monitoring children's development is an integral part of the preschool curriculum. The prerequisite for quality observation of children's development is not only knowing children well but also documenting and monitoring their development in a planned and systematic way. The preschool teacher's task is to promote children's development by teaching and planning content through activities. Children's development can be monitored using a variety of methods and techniques. The basic method is observation, followed by interviewing or talking to the child. Observation can be random or planned. Planned observation gives us greater objectivity (Rutar, 2013).

The acquisition of motor skills in childhood is crucial for the future development of context-specific actions that could improve adherence to physical activity. According to Vandoni et al. (2024), deficits in motor skills and function are associated with childhood obesity. This is the cause of impaired motor performance, executive functions, postural control, and motor coordination. Childhood obesity is negatively associated with basic motor skills and motor coordination, resulting in limited participation in and adherence to sporting activities, forming a vicious cycle. Han et al. (2018) suggest that developing motor skills and coordination in childhood could help to break this vicious cycle and reduce childhood obesity. Being overweight makes movement more difficult, so according to Kakebeeke et al. (2017), children with a high fat mass may be less skilled at some gross motor tasks.

Childhood obesity also has a negative impact on posture, with negative consequences for the musculoskeletal system. According to Molina-Garcia et al. (2020), physical capability could play a positive role in shaping the body posture of these children.

The impact of physical activity and weight status on motor skill development is complex. Motor skills influence children's growth and development in physiological, psychological, and cognitive domains (DuBose et al., 2018). Bähr et al. (2024) assessed children's motor performance using the ratio of body height to body weight (BMI).

They found that children's motor performance deteriorates with increasing body weight relative to height. Martins et al. (2003) found that in preschool children, irrespective of gender, BMI decreases with increasing scores on motor skills, ball skills, and general motor abilities. Children with higher perceived motor competence are also more physically active, have higher physical fitness, and have higher motor competence and lower BMI (Den Uil et al., 2023).

Barros et al. (2022) have shown, using neuromuscular performance tests, that children with a higher percentage of body fat have lower levels of moderate to vigorous physical activity and lower levels of gross motor coordination. Barnett et al. (2022) also show a strong positive association between motor competence and children's weight.

Changes in body weight during childhood are associated with children's motor competence, and Lima et al. (2021) conclude that even in preschool, body weight is a predictor of motor competence outcomes in early (5-7 years) and middle (7-9 years) childhood.

Methods

The measurements took place in the Hoče (Slovenia) kindergarten. The teachers and the author of the paper carried them out. Parental consent was obtained for all children.

This study aimed to investigate the development of motor efficiency in 3-4-year-old children over a period of seven months and to identify possible gender differences in motor efficiency. In the study, 45 children of both genders (21 girls, 24 boys) participated, and the mean age of the children was 38.8 months (girls) and 38.5 months (boys). The children were tested twice (baseline/test1 and endline/test2), seven months apart.

The measuring instrument comprised motor tests (Planinšič, 2019), which presumably define movement's energy component (power and speed) and movement's information component (coordination and balance). The data on motor efficiency were obtained using four motor tests of movement's energy component (long jump from standing/power, run 20 metres/speed, somersault/power, run zig-zag/speed) and four motor tests of movement's information component (walk on all fours through the rings backwards/coordination, Romberg test/balance, run 9-3-6-3-9 metres/coordination, circle the ball around the feet/coordination).

Data on children's body weight status were obtained by calculating BMI (Body Mass Index) and using percentiles (Flegal and Cole, 2013) as an indicator of children's healthy weight in relation to their height, age, and gender (Less than the 5th percentile – Underweight; 5th percentile to less than the 85th percentile - Healthy Weight; 85th to less than the 95th percentile – Overweight; Equal to or greater than the 95th percentile – Obese).

Statistical methods used for data processing were the t-test for dependent samples, t-test for independent samples, and ANOVA. The effect size of two variables (gender) was calculated using Cohen's d-index, where the effect was interpreted as 0-0.1 = insignificant effect, 0.2-0.4 = small effect, 0.5-0.7 = medium effect, and ≥ 0.8 = large effect (Cohen, 2013). For more than two variables, (motor efficiency) effect size was calculated as an eta squared ($\eta^2 = 0.01$ indicates a small effect; $\eta^2 = 0.06$ indicates a medium effect; $\eta^2 = 0.14$ indicates a large effect).

Results

Based on height and weight, BMI and percentile data were calculated according to age and gender (Table 1).

Table 1: Parameters of body dimensions and BMI.

Parameters	Girls (N=21)	Boys (N=24)
Age at test1 (months)	38.8	38.5
Height1	98.6	100.1
Height2	102.4	104.1
Weight1	15.5	15.9
Weight2	16.5	16.9
BMI1	15.9	15.8
BMI1 (Percentiles)	53.5	45.5
BMI2	15.7	15.6
BMI2 (Percentiles)	52.3	44.8

The effect size was calculated using Cohen's d-index (d). The difference in BMI percentiles between baseline and endline testing separately by gender (Table 2) is not statistically significant ($p>0.05$), the effect size for girls is small ($d=0.12$), while for boys, it is medium ($d=0.50$). The difference in BMI percentiles between genders is not statistically significant ($p>0.05$), and the effect size is small ($d<0.3$)

Table 2: BMI percentiles by testing by gender.

	Girls				Boys					
	N	Min	Max	Mean	N	Min	Max	Mean	p	d
test1	21	1.9	98.0	53.5	24.0	3.1	91.3	45.5	0.356	0.28
test2	21	1.4	94.6	52.3	24.0	4.6	87.2	44.8	0.424	0.24
p				0.593				0.810		
d				0.12				0.50		

In both tests, 2/3 of the girls had a body weight status of Healthy Weight. 4/5 boys had a Healthy Weight body weight status at baseline testing, and 9/10 boys attended testing (Table 3).

Table 3: Body weight status.

		test1		test2	
Children's body weight status		Frequency	Percent	Frequency	Percent
Girls	Underweight	2	9.5	2	9.5
	Healthy Weight	14	66.7	14	66.7
	Overweight	4	19.0	5	23.8
	Obese	1	4.8	/	
	Total	21	100.0	21	100.0
Boys	Underweight	2	8.3	/	
	Healthy Weight	19	79.2	22	91.7
	Overweight	3	12.5	2	8.3
	Obese	/		/	
	Total	24	100.0	24	100.0

Differences between baseline (test1) and endline (test2) motor efficiency by gender were tested with a t-test for dependent samples. The difference by gender (Table 4) was not statistically significant ($p > 0.05$), and the effect size (Cohen's d) was small to medium ($0.28 > d < 0.53$).

Table 4: Difference in motor efficiency by gender.

Motor efficiency		Gender	Mean	p	d
All motor tests	test1	Girls	0.049	0.616	0.15
		Boys	-0.043		
	test2	Girls	0.025	0.780	0.08
		Boys	-0.022		
Component of Energy	test1	Girls	-0.022	0.831	-0.06
		Boys	0.020		
	test2	Girls	-0.054	0.591	-0.16
		Boys	0.047		

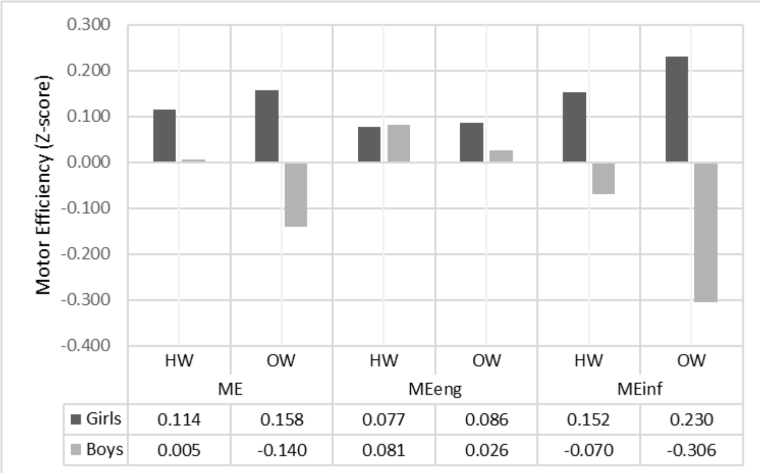
Component of Information	test1	Girls	0.120	0.282	0.33
		Boys	-0.105		
	test2	Girls	0.104	0.358	0.28
		Boys	-0.091		

Analysis of the results of testing for differences in motor efficiency according to body weight status and movement components (Table 5) showed no statistically significant differences ($p>0.05$) between healthy weight (HW) and overweight (OW) children.

Table 5: Difference in motor efficiency by body weight status by gender.

			Girls			Boys		
Motor efficiency		Children's body weight status	Mean	p	η^2	Mean	p	η^2
All motor tests	test1	HW	0.114	0.514	0.12	0.005	0.740	0.03
		OW	0.158			-0.140		
	test2	HW	-0.018	0.441	0.09	-0.064	0.290	0.05
		OW	0.240			0.444		
Component of Energy	test1	HW	0.077	0.281	0.20	0.081	0.488	0.07
		OW	0.086			0.026		
	test2	HW	-0.017	0.223	0.15	-0.030	0.093	0.12
		OW	0.066			0.897		
Component of Information	test1	HW	0.152	0.780	0.06	-0.070	0.886	0.01
		OW	0.230			-0.306		
	test2	HW	-0.020	0.420	0.09	-0.098	0.879	0.00
		OW	0.414			-0.010		

The boys' test results show a trend in the energy component of the movement ($p=0.09$). Differences between different body weight status children according to gender were tested by the t-test for independent samples. The magnitude of the effect of the independent variable (body weight status) on the dependent variable (motor efficiency) was calculated as an eta squared (η^2). The test results for boys at the final test (test2) show a small to medium effect ($\eta2<0.12$) of the independent variable (body weight status) on the dependent variable (motor efficiency). The test results for girls at both tests (test1 and test2) show a high influence ($\eta2>0.14$) of the independent variable (body weight status) on the dependent variable (motor efficiency of the energy component).



Graph 1: Motor efficiency in relation to body weight status by gender.

Graph 1 shows that in both body weight status categories (healthy weight/HW and overweight/OW) in all forms of motor efficiency (total motor efficiency, Motor efficiency of energy information component of movement, and Motor efficiency of information component of movement), girls were superior to boys.

Discussion

The survey results were obtained using an objective measurement instrument, thus excluding subjective assessment by the evaluator (Klarin et al., 2023). Some differences between girls and boys were still found to have much in common, as the most important latent motor dimensions are similar (Planinšec, 2002). This study showed a difference in motor performance in favour of children with a healthy body weight. However, given the small sample size, this difference is not statistically significant compared to the Planinšec and Matejek (2004) study. In the motor efficiency results, girls were superior to boys and, unlike the findings of Jelovčan and Zurc (2016) and Fernandes et al. (2022), more emphasis should be placed on boys when promoting children's motor development. Just under 10% of children have a body weight status of Underweight, which, according to Jelovčan and Zurc (2016), indicates the presence of mobility problems. Almost ¼ of girls have the body weight status of Overweight and Obese. Planinšec and Matejek (2004) conclude that these children tend to be less physically active.

Children with the body weight status of Underweight, Overweight, and Obese must also be provided with a rich motor environment that challenges them to develop better motor development (Sturza Milić, 2014). Associations between physical activity and fitness have been found, particularly for prolonged physical activity and more frequent vigorous exercise (Lipošek et al., 2018). Results from a study by Ljubičić et al. (2022) showed that bilateral and unilateral training significantly improves motor performance. Exercise knowledge is an essential part of a preschool teacher's competence in the motor area.

If more equipment for physical activity is added in kindergartens (Plevnik, 2021), we can expect even better motor efficiency in children.

Conclusions

The limitation of this study is the small sample size and sampling method. A random sampling technique was used, which does not guarantee a random selection of units in the sample. The number of participants was relatively low. Although the results are clear and direct, the findings are valid only for the sample used.

In future research, repeating the study on a larger, randomized sample would be worthwhile. This would make the results more relevant as they would be more representative of the population. A larger sample size also increases the study's statistical power, making the inference of differences and associations in the population more certain. This could potentially lead to more robust and generalizable findings.

The survey result was expected, as children between the ages of 3 and 4 can already learn the basic elements of sports but are still uncertain and slower (Gallahue and Ozmun, 2006).

In order to further develop motor skills, it is necessary to provide the boys with physical activities to strengthen the abilities of the movement component of information. These skills allow them better sensorimotor control when controlling movements through sports activities. For girls, it is necessary to prepare physical activities to strengthen the movement component of energy. These skills will enable them to better use their muscle work in sports activities.

The age of children is a key point in the development of motor abilities and, consequently, motor efficiency. According to Vandoni et al. (2024), early interventions prevent motor efficiency decline and influence children's overall fitness. Sports activities should be varied, numerous, and facilitated by a variety of sports equipment (Sturza Milić, 2014). Consequently, it is also necessary to gradually increase the complexity of motor content, addressing diverse domains of development from an early stage of life.

The fact that overweight and obese children tend to be less physically active (Planinšec and Matejek, 2004) and that an Underweight body weight status (Jelovčan and Zurc, 2016) is indicative of the presence of motor difficulties should be taken into account by preschool teachers when planning children's sports activities in kindergarten. The findings of the study by Molina-Garcia et al. (2020) suggest that physical fitness and functional exercise are associated with better posture in children with overweight and obesity and that for some musculoskeletal structures, they are even better predictors than their level of obesity.

Motor skills competences are key to preventing childhood obesity from an early age. To investigate a possible cause-effect relationship between motor skills and BMI from early childhood onwards, Martins et al. (2003) recommend the use of reliable longitudinal and experimental studies.

Motor competence and body weight are interrelated and equally important in child development. The findings highlighted the importance of body weight status from early childhood in developing motor competence.

Given the likelihood that body weight and motor competence promote each other synergistically (Lima et al., 2021), interventions should target both body weight status and motor competence.

According to Vandoni et al. (2024), sports activities should be fun to engage children and consider several aspects of motor development (clinical picture, fitness level, and motor abilities).

In addition to targeted physical education programs, healthy habits to maintain a normal weight during childhood should be promoted (Biino et al., 2023).

A planned, regularly implemented, and evaluated motor activity program is beneficial from early childhood onwards.

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