



RELATION BETWEEN PHYSICAL ABILITIES AND FUNDAMENTAL MOTOR SKILLS IN PRESCHOOLERS

Dejan Milenković^{1ABCD}

¹University Union – Nikola Tesla

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Dejan Milenković, dejan.milenkovic2309@gmail.com

Accepted for Publication: December 9, 2022

Published: December 23, 2022

DOI: 10.17309/tmfv.2022.4.15

Abstract

The aim of this study was to determine the interconnection between physical abilities and fundamental motor skills in preschool children. The aim was also to determine the differences in the observed variables in relation to gender.

Materials and methods. The testing successfully included 52 preschool children, 30 boys and 22 girls. Five tests of physical ability (modified agility "T" (MAT) test, broad jump test, standing balance test, squat test and sit up test) were used, and fundamental motor skills were assessed with the Test of Gross Motor Development, 3rd edition (TGMD-3). One-way ANOVA was used to determine the effects of gender on results in physical abilities and fundamental motor skills. The Pearson product-moment correlation coefficient was used to determine the relation between physical abilities and fundamental motor skills.

The results of this work indicated, in most cases, a moderate and significant correlation of fundamental motor skills and parameters of physical abilities both in the total sample and also individually in boys and girls ($p \leq 0.05$). A significant difference in almost all variables of physical abilities and fundamental motor skills was noted in favor of boys ($p \leq 0.05$ and $p \leq 0.01$), except for the Standing balance test which indicated that there were not considerable differences between the sexes ($p > 0.05$).

Conclusions. So it can be concluded that the information obtained can lead physical education educators to better understanding of the relations between motor status variables, which further enables them to work effectively with children who will, by virtue of a proper physical development and education, become and remain physically active throughout their life.

Keywords: gross motor development, children, agility, strength, balance.

Introduction

Motor development can be defined as the gradual acquisition of control and/or the use of more and less muscle mass. Due to the interaction of the nervous and muscular systems, which enables the child to skillfully navigate in space, manipulate objects and explore the world around him, it is often called "perceptual-motor development", as well as "physical or motor coordination" (Williams & Monsma, 2006). Gross motor development in early childhood is important for achieving greater interaction with the environment (Kit et al., 2017) and is recognized as a means of assessing the overall level of child development during the earliest months and years of their life (Dewey et al., 2002).

In addition to acquiring and improving the level of physical abilities, motor development is also characterized by mastering motor skills, which begins from the earliest childhood and lasts until adulthood (Milenković, 2021).

Even O'Brien & Hayes (1994) and Williams (1983) considered the period from 2 to 6 years of one's life to be the "golden age" of motor development, and modern research recognizes it as being a valid assertion (Figueroa & An, 2017; Goodway, Ozmun & Gallahue, 2021; Pedersen & Hansen, 2022). In the course of the aforementioned period, children create a basis for the functioning of the body for the later stage of development through the acquisition of a large number of fundamental locomotor and manipulative skills, because the early years are the basis for neuromuscular coordination that each individual uses throughout life to engage in many mental, social, emotional and recreational dimensions of life (Williams & Monsma, 2006). Locomotor skills are the movement of the body through space and include walking, running, jumping, galloping,

climbing, descending, sliding, while manipulative are the skills of controlling objects and include throwing, catching, hitting, kicking, shooting, etc. (Haywood & Getchell, 2020).

Motor skills improve in the established order from the most fundamental to the most complex voluntary movements that keep improving by constant exercise (Milenković, 2021). The learning process and the basis for the development of motor skills are closely connected with play and physical activity in which different motor skills are used (Cech & Martin, 2012; Riethmuller, Jones & Okely, 2009). Children have a natural tendency to study their body and the world around them, while developing their motor skills (Williams & Monsma, 2006). Most developmental changes in motor performance over time are considered a product of maturity and general interaction with the environment and occur linearly (Haubenstricker & Seefeldt, 1986), however, it has been shown that children can learn motor skills if appropriate training programs are implemented and if sufficient exercise time is provided (Zipp & Gentile, 2010; Brown, 2010; Palmer et al., 2020), because motor skills are significantly correlated with cognitive development factor (Iivonen & Sääkslahti, 2014; Van der Fels et al., 2015; Gandotra et al., 2022).

The factors which motor skills depend on concern the growth and development of the body, physical and cardiorespiratory abilities required to perform motor skills (Haapala, 2013), then the maturation of the central nervous system (Pecuch et al., 2021), talent (Faber et al., 2020) and at the end on constant physical activity (Iivonen et al., 2013), i.e. practicing and improving motor skills (Milenković, 2021). The dynamics of changes in motor skills is not the same in every child of the same age, often due to the amount of time the child has spent practicing a certain skill, which affects the lower or higher level of motor competence and ability to participate in physical activity (Hands, 2008). In terms of overcoming these differences, physical education as an organized physical exercise offers a variety of contents that allow children to try on different activities, meeting their needs for movement and expanding the range of their motor skills and quality of their performance, which makes them ready for everyday life (Mostafavi et al., 2013; Lorås, 2020).

The proven reliable and valid Test of Gross Motor Development (TGMD) by D.A Ulrich is often used for the research purposes to assess motor development in children. After the first edition of the test (Ulrich & Sanford, 1985) which had the task of dealing with shortcomings in instruments for assessing motor behavior (lack of standardization, difficulties in identifying specific aspects of movement, impossibility of mutual comparison), a second edition appeared (Ulrich, 2000) as an improvement of the tests from the first edition with the criterion and normative standardization (Kit et al., 2017). An even newer third edition of this test (Ulrich, 2016) also allows a successful assessment of motor development intended for children from 3 to 10 years of age, both in healthy children (Maeng, Webster & Ulrich, 2016; Rintala, Sääkslahti & Iivonen, 2017; Mohammadi et al., 2017), and in children with certain developmental disabilities (Allen et al., 2017). Editions of this test provide an effective tool for assessing fundamental motor skills. There is a relatively acceptable matching between TGMD-2 and TGMD-3 in the obtained raw scores and somewhat less strength for percentile scores, which indicates similarity, but not interchangeability of these editions (Palmer et al., 2021).

This research aims to determine the relationship between physical abilities and fundamental motor skills in preschool children. It is also necessary to determine the differences in the observed variables in relation to gender.

Materials and methods

Participants

60 preschool children took the test. The testing was successfully completed by 52 children, 30 boys and 22 girls (Table 1). The written permission of the parents of all children to participate in this research was obtained, as well as the consent of the children themselves. The research was organized in accordance with the recommendations for clinical research given by the World Health Organization (WHO) within the Helsinki Declaration (2013).

Measuring instruments

Physical Fitness. Five tests were used in the testing, which have so far been found to be reliable and valid for assessing physical abilities (tests of agility, explosive and repetitive strength and balance). A closer look at the procedures and the scoring systems can be found on the Topend Sports website (Wood, 2008):

- Modified agility „T“ (MAT) test (Sassi, et al., 2009);
- Broad jump test (Castro-Piñero et al., 2010);
- Standing balance test (Šarabon & Omejec, 2007);
- Squat test (30sec) (Blazevich, Gill & Newton, 2002);
- Sit up test (30sec) (Ojeda, Maliqueo & Barahona-Fuentes, 2020).

The Witty Timing System (Microgate, Bolzano, Italy) was used to measure the time when performing the Agility T test. A digital stopwatch was used to measure time when performing other physical fitness tests. A measuring tape was used for the Broad jump test.

Fundamental Motor Skills. The Test of Gross Motor Development – 3rd edition (TGMD-3) (according to Ulrich, 2016) was used in the testing. TGMD-3 is a criterion-based and normatively standardized test that assesses the fundamental motor skills of children aged 3 to 10. The TGMD-3 consists of a locomotor and ball skills subtest. The Locomotor subtest measures fundamental motor skills that require fluent and coordinated movement of the child, while the Ball Skills subtest measures fundamental motor skills that demonstrate the movements of efficient throwing, catching and striking. Each motor skill is assessed through three to five criteria based on whether the criterion is met (1 point) or not (0 points). For each motor skill, two attempts are evaluated, after which the points obtained for each criterion within the performed motor skill are added up. The maximum score that a respondent can achieve on the TGMD-3 is a total of 100 points, 46 points on the locomotor subtest and 54 points on the ball skills subtest. The usual duration of TGMD-3 is 15-20 minutes per the testee.

Testing procedure

Testing of physical abilities and fundamental motor skills was performed by trained investigators in the gym of the preschool institution. Two days earlier, a trial test was organized to prepare the children for the complete

procedure they would undergo during the experimental testing. A warm-up of 15 minutes was performed before each test. Each of the tests of physical abilities was repeated three times, so the best result was taken for further analysis. After completing each test and before moving on to the next, there was a 5–8 minutes break in order to avoid negative effects on testing caused by fatigue. TGMD-3 was performed according to the description presented earlier.

When it comes to assessing fundamental motor skills, before the implementation of TGMD-3, investigators were specially trained to administer the test. In order to ensure the interrater-reliability of TGMD-3, two investigators that underwent a standardized measurement procedure, independently assessed the performance of the subjects. After completing the testing of physical abilities and fundamental motor skills, data processing began.

Statistical analysis

In addition to the descriptive parameters (Mean $\pm$ St.Dev) for all variables, the one-way ANOVA was used to determine the effect of gender on scores in physical abilities and fundamental motor skills. The Pearson product-moment correlation coefficient was used as well to determine the relation between physical abilities and fundamental motor skills. The Pearson product-moment correlation coefficient can be interpreted as the effect size and it indicates the strength of the relation between the two variables. According to Cohen's (1988), the correlation coefficient of .10 and above is considered a weak or small correlation, of .30 and over represents a moderate correlation, and of .50 or over represents a strong or large correlation. Statistical significance was established at the levels of $p \leq 0.05$ and $p \leq 0.01$.

Results

The following chapter presents the obtained research results in change of direction speed, explosive strength and running speed (Tables 1 and 2), as well as their interpretation.

Table 1. Descriptives (Mean $\pm$ St.Dev) and difference between genders

Indicator	Total (n=52)	Boys (n=30)	Girls (n=22)
Age (y)	5.74 $\pm$ 0.9	5.46 $\pm$ 0.5	5.83 $\pm$ 0.9
TGDM-3 (raw score)	65.50 $\pm$ 10	69.93 $\pm$ 8.4 ^b	59.45 $\pm$ 8.7
Locomotor skills subtest (raw score)	29.31 $\pm$ 5.8	32.03 $\pm$ 4.6 ^b	25.59 $\pm$ 5.3
Ball skills subtest (raw score)	36.29 $\pm$ 4.9	38.07 $\pm$ 4.5 ^b	33.86 $\pm$ 4.3
MAT test	9.61 $\pm$ 0.3	9.41 $\pm$ 0.3 ^b	9.88 $\pm$ 0.2
Broad jump test	113.06 $\pm$ 8.79	117.10 $\pm$ 7.4 ^a	107.55 $\pm$ 7.6
Standing balance test	41.04 $\pm$ 4.3	40.19 $\pm$ 5.3	42.18 $\pm$ 1.8
Squat test	21.15 $\pm$ 1.7	21.63 $\pm$ 1.8 ^a	20.50 $\pm$ 1.4
Sit up test	10.08 $\pm$ 2.4	11.17 $\pm$ 2.3 ^b	8.59 $\pm$ 1.9

^aSignificance between boys and girls $p \leq 0.05$;

^bSignificance between boys and girls $p \leq 0.01$; TGDM-3 – Test of Gross Motor Development – 3rd edition

Table 1 contains descriptive data of all variables of this study presented in total and by gender. Variables include total TGMD-3 score, locomotor subtest score, ball skills subtest score, and physical ability tests (MAT test, Broad jump test, Standing balance test, Squat test and Sit up test). If the difference between boys and girls is observed, significantly better results of boys in relation to girls can be determined for almost all variables: TGMD-3 ($F = 19.03$, $p < 0.001$), locomotor subtest ($F = 22.05$, $p < 0.001$), ball skills subtest ($F = 11.43$, $p < 0.001$), MAT test ($F = 45.73$, $p < 0.001$), Broad jump test ($F = 20.81$, $p < 0.001$), Squat test ($F = 5.89$, $p = 0.019$) and Sit up test ($F = 18.19$, $p < 0.001$). Significant differences between boys and girls were not observed in the Standing balance test ($F = 2.86$, $p = 0.097$).

Table 2. Pearson correlation coefficient between TGDM-3 scores (total and by subtests) and physical fitness by gender

Indicator	MAT test		
	Total	Boys	Girls
TGDM-3	-0.759 ^b	-0.628 ^b	-0.797 ^b
Locomotor skills subtest	-0.767 ^b	-0.606 ^b	-0.724 ^b
Ball skills subtest	-0.666 ^b	-0.613 ^b	-0.646 ^b
Broad jump test			
TGDM-3	0.767 ^b	0.637 ^b	0.784 ^b
Locomotor skills subtest	0.744 ^b	0.615 ^b	0.636 ^b
Ball skills subtest	0.697 ^b	0.566 ^b	0.803 ^b
Standing balance test			
TGDM-3	0.391 ^b	0.590 ^b	0.605 ^b
Locomotor skills subtest	0.279 ^a	0.468 ^b	0.584 ^b
Ball skills subtest	0.431 ^b	0.596 ^b	0.520 ^a
Squat test			
TGDM-3	0.788 ^b	0.702 ^b	0.691 ^b
Locomotor skills subtest	0.810 ^b	0.819 ^b	0.628 ^b
Ball skills subtest	0.658 ^b	0.549 ^b	0.588 ^b
Sit up test			
TGDM-3	0.728 ^b	0.696 ^b	0.565 ^b
Locomotor skills subtest	0.720 ^b	0.650 ^b	0.522 ^b
Ball skills subtest	0.623 ^b	0.634 ^b	0.432 ^a

^aSignificant correlation is $p \leq 0.05$;

^bSignificant correlation is $p \leq 0.01$; TGDM-3 – Test of Gross Motor Development – 3rd edition

The relation between physical abilities and fundamental motor skills (shown as the total score of TGMD-3, locomotor subtest and ball skills subtest) are given in Table 2.

When analyzing the total sample a significant correlation is perceived which is mostly of strong effect size between almost all tests of physical abilities and the total result of TGMD-3 (MAT test -0.759; Broad jump test 0.767; Squat test 0.788; Sit up test 0.728), except Standing balance test 0.391 with moderate effect size. It is similar in the case of the connection of physical abilities with subtests: locomotor subtest (strong effect size: MAT test -0.767; Broad jump test 0.744; Squat test 0.810; Sit up test 0.720; small but significant correlation: Standing balance test 0.279) and balls skills

subtest (strong effect size: MAT test -0.666; Broad jump test 0.697; Squat test 0.658; Sit up test 0.623; moderate effect size: Standing balance test 0.431).

When the sample is observed from the gender point of view, a significant correlation between the variables of physical abilities and fundamental motor skills is noticed in both boys and girls. In boys, there is a strong and significant correlation of all tests of physical abilities with the overall result of TGMD-3. Results are the same both in locomotor and ball skills subtests. In girls, most coefficients between physical abilities and subtests are significant and strongly correlated, except moderate effect size between ball skills subtest and Sit up test (0.432).

Discussion

The aim of this study was to determine the connexion between physical abilities and fundamental motor skills in preschool children. It was also necessary to determine the differences in the observed variables in relation to gender.

Observing the connection between physical abilities and fundamental motor skills, the results of this paper indicate in most cases a moderate and significant correlation of fundamental motor skills and physical ability parameters in the total sample and also individually in boys and girls ($p \leq 0.05$). Similar results can be found in other researches dealing with the physical performances of preschool children. Burns, Brusseau & Hannon (2017) found a significant correlation between ball skills subtest and physical performances, but on the other hand, there was no significant interconnection between locomotor subtest TGMD-3 and physical performances. However, the relation between the parameters of fundamental motor skills and physical abilities is dynamic and can change during the childhood, so the development of object management skills in childhood can be important for the development and maintenance of physical abilities during childhood and adolescence (Stodden et al., 2014). This dynamic relation between motor competence and physical ability keeps strengthening with age (Utesch et al., 2019), which has been fully accepted by Stodden et al. (2008), indicating that physical ability plays the role of mediator in the emergent relationship between motor competencies and physical activities and that as a child is growing from early to middle childhood, the relationship of these elements from the initial weak connection is becoming stronger.

It is considered that the cause of low levels of physical activity in children is an insufficient level of physical abilities, as well as a lack of motor competence, ie. low level of fundamental motor skills (Erwin & Castelli, 2008). The research shows that the relation between physical parameters and fundamental motor skills is significantly related to the general level of physical activity in children (Castelli & Valley, 2007; Logan et al., 2015; Webster, Martin & Staiano, 2019; Hu, Wu & Kong, 2022), which also affects later age, as active children become active adults (Janz, Dawson & Mahoney, 2000). Any movement in the form of free activity has a positive effect on fundamental motor skills (Kracht, Webster & Staiano, 2020; Li, Yin, Sun & Gao, 2022), which is also true for the impact of organized programs on physical performances through cardiorespiratory endurance and fundamental motor skills as well (Brusseau et al., 2018).

When it comes to the differences in the observed variables of physical abilities and fundamental motor skills in

relation to gender, the results of this study showed a significant difference in almost all variables of physical abilities and fundamental motor skills in favor of boys ($p \leq 0.05$ and $p \leq 0.01$), except for the Standing balance test in which there are not significant differences ($p > 0.05$). These results are consistent with previous research that suggests similar conclusions (Robinson, 2011; Bonvin et al., 2012; Vameghi, Shams & Dehkordi, 2013; Mnejja et al., 2022). Barnett et al. (2010) concluded that boys control objects better than girls, and Goodway, Robinson & Crowe (2010) who dealt with determining the difference between boys and girls in object control and locomotor skills, agree upon that matter. The reason for such differences between boys and girls can be found in the various leisure activities and games which children participate in. It is common for boys and girls to play in different ways during their childhood and some of these activities are in a greater extent in favor of the development of physical abilities and motor skills in boys, and to a lesser extent in girls. In addition to the different ways of playing, the cultural and social factors of the environment in which children grow up also make a certain contribution, so dolls are intended for girls, and balls and other sports equipment for boys. Boys are directed to ball games, climbing, skipping, dragging and other more "dangerous" activities, while safer games with less physical engagement are intended for girls. In this regard, children's development should not only rely on free activities, but, already confirmed by numerous other studies (Roth et al., 2015; Salaj, Krmpotić & Stamenković, 2016; Johnson et al., 2019; Hudson, Ballou & Willoughby, 2021), it is also necessary to conduct programmed exercise within institutionalized physical education, initially in preschool and then later in school institutions (Milenković, 2022). All the mentioned researches indicate a positive effect of organized and planned exercise on the development of physical abilities and fundamental motor skills in preschool children. In addition to the positive impact of free activities and play on motor development, working with children requires professional and organized physical exercise in appropriate educational institutions. In that way, the difference in motor development between boys and girls can be reduced.

The limitations of this research are in the small sample of respondents and the fact that the sample was taken from two preschool institutions. Capturing a wider population and a larger number of respondents would undoubtedly provide much more precise and reliable results. Besides, a number of physical performance parameters can be taken into account that would more fully cover all segments of motor skills. Nevertheless, this research provides sufficient information that can indicate the importance of motor development of preschool children and serve for some new research based on the previous ones, can result in more complete picture of this problem.

Conclusion

Due to the different levels of physical activity to which they are exposed, children may have a rich and varied movement experience versus children whose motor manifestations are poor. This is why it is necessary to expose preschoolers to an appropriate level of physical activity that will cause adaptive changes in motor skills and enable the development of those skills. Institutionalized physical exercise in

the form of preschool physical education plays an important role in this process. In order to improve the motor status and proper development of the organism, the work program requires professional planning, diverse and interesting content, adequate feedback, instructions and encouragement of educators as a contribution to raising self-confidence, especially for children with poor motor skills. When it comes to the results of this research, the information obtained can help the physical education educators to achieve better understanding of the relationship between variables of motor status, which further allows them to work effectively with children who will become physically active throughout physical development and education throughout their life.

Conflict of interest

The author did not receive support from any organization for the submitted work. The author has no relevant financial or non-financial interests to disclose.

References

- Williams, H., & Monsma, E.V. (2006). *Assessment of gross motor development*. In B.A. Bracken & R.J. Nagle (Eds), *Psychoeducational Assessment of Preschool Children*, 4th edition, (pp. 397-433). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Kit, B.K., Akinbami, L.J., Isfahani, N.S., & Ulrich, D.A. (2017). Gross Motor Development in Children Aged 3–5 Years, United States 2012. *Maternal and Child Health Journal*, 21(7), 1573-1580. <https://doi.org/10.1007/s10995-017-2289-9>
- Dewey, D., Kaplan, B., Crawford, S., & Wilson, B. (2002). Developmental coordination disorder: Associated problems in attention, learning, and psychosocial adjustment. *Human Movement Science*, 21(5-6), 905-918. [https://doi.org/10.1016/S0167-9457\(02\)00163-X](https://doi.org/10.1016/S0167-9457(02)00163-X)
- Milenković, D. (2021). *Fizičko vaspitanje i sport (Physical education and sport)*. Belgrade: Faculty of Sport, University Union – Nikola Tesla.
- O'Brien, C., & Hayes, A. (1994). *Normal and impaired motor development: theory into practice*. London: Chapman & Hall Publishers.
- Williams, H. (1983). *Perceptual and motor development in young children*. Englewood Cliffs, NJ: Prentice-Hall.
- Figueroa, R., & An, R. (2017). Motor Skill Competence and Physical Activity in Preschoolers: A Review. *Maternal and Child Health Journal*, 21, 136-146. <https://doi.org/10.1007/s10995-016-2102-1>
- Goodway, J.D., Ozmun, J.C., & Gallahue, D.L. (2021). *Understanding Motor Development: Infants, Children, Adolescents, Adults, 8th edition*. Burlington, MA: Jones & Bartlett Learning.
- Pedersen, M.R.L., & Hansen, A. F. (2022). Interventions by Caregivers to Promote Motor Development in Young Children, the Caregivers' Attitudes and Benefits Hereof: A Scoping Review. *International Journal of Environmental Research and Public Health*, 19(18), 11543. <https://doi.org/10.3390/ijerph191811543>
- Haywood, K.M., & Getchell, N. (2020). *Lifespan motor development* (7th ed.). Champaign, IL: Human Kinetics.
- Cech, D.J., & Martin, S. (2012). *Functional Movement Development: across the lifespan* (3rd edition). St. Louis, Missouri: Elsevier Saunders.
- Riethmuller, A.M., Jones, R.A., & Okely, A.D. (2009). Efficacy of interventions to improve motor development in young children: A systematic review. *Pediatrics*, 124(4), e782-e792. <https://doi.org/10.1542/peds.2009-0333>
- Haubenstricker, J. & Seefeldt, V. (1986). *Acquisition of Motor Skills During Childhood*. In V. Seefeldt (ed), *Physical Activity & Well-being* (pp. 49-110). Reston, Virginia: American Alliance for Health, Physical Education, Recreation and Dance.
- Zipp, G.P., & Gentile, A.M. (2010). Practice Schedule And The Learning Of Motor Skills In Children And Adults: Teaching Implications. *Journal of College Teaching and Learning*, 7(2), 35-42. <https://doi.org/10.19030/tlc.v7i2.87>
- Brown, C.G. (2010). Improving fine motor skills in young children: an intervention study. *Educational Psychology in Practice*, 26(3), 269-278. <https://doi.org/10.1080/02667363.2010.495213>
- Palmer, K.K., Harkavy, D., Rock, S.M., & Robinson, L.E. (2020). Boys and Girls Have Similar Gains in Fundamental Motor Skills Across a Preschool Motor Skill Intervention. *Journal of Motor Learning and Development*, 8(3), 569-579. <https://doi.org/10.1123/jmld.2019-0043>
- Iivonen, K.S., & Sääkslahti, A.K. (2014). Preschool children's fundamental motor skills: a review of significant determinants. *Early Child Development and Care*, 184(7), 1107-1126. <https://doi.org/10.1080/03004430.2013.837897>
- Van der Fels, I.M.J., te Wierike, S.C.M., Hartman, E., Elferink-Gemser, T.E., Smith, J., & Visscher, C. (2015). The relationship between motor skills and cognitive skills in 4–16 year old typically developing children: A systematic review. *Journal of Science and Medicine in Sport*, 18(6), 697-703. <https://doi.org/10.1016/j.jsams.2014.09.007>
- Gandotra, A., Csaba, S., Sattar, Y., Cserényi, V., Bizonics, R., Cserjesi, R., & Kotyuk, E. (2022). A Meta-analysis of the Relationship between Motor Skills and Executive Functions in Typically-developing Children. *Journal of Cognition and Development*, 23(1), 83-110. <https://doi.org/10.1080/15248372.2021.1979554>
- Haapala, E.A. (2013). Cardiorespiratory Fitness and Motor Skills in Relation to Cognition and Academic Performance in Children – A Review. *Journal of Human Kinetics*, 36(1), 55-68. <https://doi.org/10.2478/hukin-2013-0006>
- Pecuch, A., Gieysztor, E., Wolanska, E., Telenga, M., & Paprocka-Borowicz, M. (2021). Primitive Reflex Activity in Relation to Motor Skills in Healthy Preschool Children. *Brain Sciences*, 11(8), 967. <https://doi.org/10.3390/brainsci11080967>
- Faber, I., Zamoscinska, M., Teunissen, J.W., & Pion, J. (2020). The relationship between sport-specific training and a perceptuo-motor skills assessment as part of talent identification in young table tennis players (8-10 years). *International journal of Racket Sports Science*, 2(1), 42-54. <https://doi.org/10.30827/Digibug.63720>
- Iivonen, K.S., Sääkslahti, A.K., Mehtälä, A., Villberg, J.J., Tammelin, T.H., Kulmala, J.S., & Poskiparta, M. (2013). Relationship between Fundamental Motor Skills and

- Physical Activity in 4-Year-Old Preschool Children. *Perceptual and Motor Skills*, 117(2), 627-646. <https://doi.org/10.2466/10.06.PMS.117x22z7>
- Hands, B. (2008). Changes in motor skill and fitness measures among children with high and low motor competence: A five-year longitudinal study. *Journal of Science and Medicine in Sport*, 11(2), 155-162. <https://doi.org/10.1016/j.jsams.2007.02.012>
- Mostafavi, R., Ziaee, V., Akbari, H., & Haji-Hosseini, S. (2013). The Effects of SPARK Physical Education Program on Fundamental Motor Skills in 4-6 Year-Old Children. *Iranian Journal of Pediatrics*, 23(2), 216-219. 23724186
- Lorås, H. (2020). The Effects of Physical Education on Motor Competence in Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports*, 8(6), 88. <https://doi.org/10.2466/10.3390/sports8060088>
- Ulrich, D.A., & Sanford, C.B. (1985). *Test of gross motor development*. Austin, TX, USA: Pro-Ed.
- Ulrich, D.A. (2000). *Test of gross motor development* (2nd edition). Austin, TX: PRO-ED.
- Ulrich, D.A. (2016). *Test of gross motor development* (3rd edition). Austin, TX, USA: Pro-Ed. <https://sites.google.com/view/tgmd-3/home>
- Maeng, H.J., Webster, E.K., & Ulrich, D.A. (2016). Reliability for the Test of Gross Motor Development-Third Edition (TGMD-3). *Research Quarterly for Exercise and Sport*, 87(S2), A38. <https://www.proquest.com/openview/e1e94139646d16424771c0d1ab36f697/1?pq-origsite=gscholar&cbl=40785>
- Rintala, P.O., Sääkslahti, A.K., & Iivonen, K.S. (2017). Reliability Assessment of Scores from Video-Recorded TGMD-3 Performances. *Journal of Motor Learning and Development*, 5(1), 59-68. <https://doi.org/10.1123/jmld.2016-0007>
- Mohammadi, F., Bahram, A., Khalaji, H., & Ghadiri, F. (2017). The Validity and Reliability of Test of Gross Motor Development – 3rd Edition among 3-10 Years Old Children in Ahvaz. *Jundishapur Scientific Medical Journal*, 16(4), 379-391. <https://doi.org/10.22118/JSMJ.2017.51022>
- Allen, K. A., Bredero, B., Van Damme, T., Ulrich, D.A., & Simons, J. (2017). Test of Gross Motor Development-3 (TGMD-3) with the Use of Visual Supports for Children with Autism Spectrum Disorder: Validity and Reliability. *Journal of Autism and Developmental Disorders*, 47(3), 813-833. <https://doi.org/10.1007/s10803-016-3005-0>
- Palmer, K.K., Chinn, K.M., Scott-Andrews, K.Q., & Robinson, L.E. (2021). An Intervention-Related Comparison of Preschoolers' Scores on the TGMD-2 and TGMD-3. *Perceptual and Motor Skills*, 128(4), 1354-1372. <https://doi.org/10.1177/00315125211013217>
- World Medical Association Declaration of Helsinki (2013). Ethical Principles for Medical Research Involving Human Subjects, 64th WMA General Assembly, Fortaleza, Brazil, October 2013. Retrieved November 25, 2020 from the World Wide Web: <http://www.wma.net/en/30publications/10policies/b3/index.html>
- Wood, R.J. (2008). *Fitness Test list*, [Online], Available: <https://www.topendsports.com/testing/tests/index.htm> [21 December 2021].
- Sassi, R.H., Dardouri, W., Yahmed, M.H., Gmada, N., Mahfoudhi, M.E., & Gharbi, Z. (2009). Relative and absolute reliability of a modified agility t-test and its relationship with vertical jump and straight sprint. *Journal of Strength and Conditioning Research*, 23(6), 1644-1651. <https://doi.org/10.1519/jsc.0b013e3181b425d2>
- Castro-Piñero, J., Ortega, F., Artero, E.G., Girela-Rejón, M.J., Mora, J., Sjöström, M., & Ruiz, J.R. (2010). Assessing Muscular Strength in Youth: Usefulness of Standing Long Jump as a General Index of Muscular Fitness. *Journal of Strength and Conditioning Research*, 24(7), 1810-1817. <https://doi.org/10.1519/jsc.0b013e3181ddb03d>
- Šarabon, N., & Omejec, G. (2007). A Novel Testing Tool for Balance in Sports and Rehabilitation. In T. Jarm, P. Kramar & A. Zupanec (eds), *11th Mediterranean Conference on Medical and Biomedical Engineering and Computing, IFMBE Proceedings*, 16 (pp 998-1001). Ljubljana, Slovenia: Springer.
- Blazevich, A.J., Gill, N., & Newton, R.U. (2002). Reliability and validity of two isometric squat tests. *Journal of Strength and Conditioning Research*, 16(2), 298-304. <https://doi.org/10.1519/00124278-200205000-00020>
- Ojeda, A.H., Maliqueo, S.G., & Barahona-Fuentes, G. (2020). Validity and reliability of the Muscular Fitness Test to evaluate body strength-resistance. *Apunts Sports Medicine*, 55(208), 128-136. <https://doi.org/10.1016/j.apunsm.2020.08.002>
- Cohen, J. (1988) *Statistical Power Analysis for the Behavioural Sciences*. Hillsdale, NJ, USA: Lawrence Erlbaum Associates.
- Burns, R., Brusseau, T., & Hannon, J. (2017). Multivariate Associations Among Health-Related Fitness, Physical Activity, and TGMD-3 Test Items in Disadvantaged Children From Low-Income Families. *Perceptual and Motor Skills*, 124(1), 86-104. <https://doi.org/10.1177/0031512516672118>
- Stodden, D.F., Gao, Z., Goodway, J.D., & Langendorfer, S.J. (2014). Dynamic Relationships Between Motor Skill Competence and Health-Related Fitness in Youth. *Pediatric exercise science*, 26(3), 231-241. <https://doi.org/10.1123/pes.2013-0027>
- Utesch, T., Bardid, F., Büsch, D., & Strauss, B. (2019). The Relationship Between Motor Competence and Physical Fitness from Early Childhood to Early Adulthood: A Meta-Analysis. *Sports Medicine*, 49, 541-551. <https://doi.org/10.1007/s40279-019-01068-y>
- Stodden, D.F., Goodway, J.D., Langendorfer, S.J., Robertson, M.A., Rudisill, M.E., Garcia, C., & Garcia, L.E. (2008). A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. *Quest*, 60(2), 290-306. <https://doi.org/10.1080/00336297.2008.10483582>
- Erwin, H.E., & Castelli, D.M. (2008). National physical education standards: A summary of student performance and its correlates. *Research Quarterly for Exercise and Sport*, 79(4), 495-505. <https://doi.org/10.1080/02701367.2008.10599516>
- Castelli, D.M., & Valley, J.A. (2007). The Relationship of Physical Fitness and Motor Competence to Physical Activity. *Journal of Teaching in Physical Education*, 26(4), 358-374. <https://doi.org/10.1123/jtpe.26.4.358>
- Logan, S.W., Webster, E.K., Getchell, N., Pfeiffer, K.A., & Robinson, L.E. (2015). Relationship Between

- Fundamental Motor Skill Competence and Physical Activity During Childhood and Adolescence: A Systematic Review. *Kinesiology Review*, 4(4), 416-426. <https://doi.org/10.1123/kr.2013-0012>
- Webster, E.K., Martin, C.K., & Staiano, A.E. (2019). Fundamental motor skills, screen-time, and physical activity in preschoolers. *Journal of Sport and Health Science*, 8(2), 114-121. <https://doi.org/10.1016/j.jshs.2018.11.006>
- Hu, B. Y., Wu, Z., & Kong, Z. (2022). Family physical activities choice, parental views of physical activities, and Chinese preschool children's physical fitness and motor development. *Early Childhood Education Journal*, 50(5), 841-853. <https://doi.org/10.1007/s10643-021-01190-5>
- Janz, K.F., Dawson, J.D., & Mahoney, L.T. (2000). Tracking physical fitness and physical activity from childhood to adolescence: The Muscatine Study. *Medicine & Science in Sports & Exercise*, 32(7), 1250-1257. <https://doi.org/10.1097/00005768-200007000-00011>
- Kracht, C.L., Webster, E.K., & Staiano, A.E. (2020). Relationship between the 24-Hour Movement Guidelines and fundamental motor skills in preschoolers. *Journal of Science and Medicine in Sport*, 23(12), 1185-1190. <https://doi.org/10.1016/j.jsams.2020.06.021>
- Li, F., Yin, L., Sun, M., & Gao, Z. (2022). Examining Relationships among Chinese Preschool Children's Meeting 24-Hour Movement Guidelines and Fundamental Movement Skills. *Journal of Clinical Medicine*, 11(19), 5623. <https://doi.org/10.3390/jcm11195623>
- Brusseau, T.A., Hannon, J.C., Fu, Y., Fang, Y., Nam, K., Goodrum, S., & Burns, R.D. (2018). Trends in physical activity, health-related fitness, and gross motor skills in children during a two-year comprehensive school physical activity program. *Journal of Science and Medicine in Sport*, 21(8), 828-832. <https://doi.org/10.1016/j.jsams.2017.12.015>
- Robinson, L.E. (2011). The relationship between perceived physical competence and fundamental motor skills in preschool children. *Child: care, health and development*, 37(4), 589-596. <https://doi.org/10.1111/j.1365-2214.2010.01187.x>
- Bonvin, A., Barral, J., Kakebeeke, T.H., Kriemler, S., Longchamp, A., Marques-Vidal, P., & Puder, J.J. (2012). Weight status and gender-related differences in motor skills and in child care – based physical activity in young children. *BMC Pediatrics*, 12, 23. <https://doi.org/10.1186/1471-2431-12-23>
- Vameghi, R., Shams, A., & Dehkordi, P.S. (2013). The effect of age, sex and obesity on fundamental motor skills among 4 to 6 years-old children. *Pakistan Journal of Medical Sciences*, 29(2), 586-589. <http://doi.org/10.12669/pjms.292.3069>
- Mnejja, K., Fendri, T., Chaari, F., Harrabi, M. A., & Sahli, S. (2022). Reference values of postural balance in preschoolers: Age and gender differences for 4–5 years old Tunisian children. *Gait & Posture*, 92, 401-406. <https://doi.org/10.1016/j.gaitpost.2021.12.015>
- Barnett, L.M., van Beurden, E., Morgan, P.J., Brooks, L.O., & Beard, J.R. (2010). Gender Differences in Motor Skill Proficiency From Childhood to Adolescence. *Research Quarterly for Exercise and Sport*, 81(2), 162-170. <https://doi.org/10.1080/02701367.2010.10599663>
- Goodway, J.D., Robinson, L.E., & Crowe, H. (2010). Gender Differences in Fundamental Motor Skill Development in Disadvantaged Preschoolers From Two Geographical Regions. *Research Quarterly for Exercise and Sport*, 81(1), 17-24. <https://doi.org/10.1080/02701367.2010.10599624>
- Roth, K., Kriemler, S., Lehmacher, W., Ruf, K.C., Graf, C., & Hebestreit, H. (2015). Effects of a Physical Activity Intervention in Preschool Children. *Medicine and Science in Sports and Exercise*, 47(12), 2542-2551. <https://doi.org/10.1249/MSS.0000000000000703>
- Salaj, S., Krmpotić, M., & Stamenković, I. (2016). Are Specific Programs a Threat to Overall Motor Development of Preschool Children? *Kinesiology Slovenica*, 22(1), 47-55.
- Johnson, J.L., Rudisill, M.E., Hastie, P., Wadsworth, D., Strunk, K., Venezia, A., Sassi, J., Morris, M., & Merrit, M. (2019). Changes in Fundamental Motor-Skill Performance Following a Nine-Month Mastery Motivational Climate Intervention. *Research Quarterly for Exercise and Sport*, 90(4), 517-526. <https://doi.org/10.1080/02701367.2019.1628909>
- Hudson, K.N., Ballou, H.M., & Willoughby, M.T. (2021). Short report: Improving motor competence skills in early childhood has corollary benefits for executive function and numeracy skills. *Developmental Science*, 24(4), e13071. <https://doi.org/10.1111/desc.13071>
- Milenković, D. (2022). Effect of the Eight-Week Agility Development Program in Elementary School Students. *Physical Education Theory and Methodology*, 22(1), 134-141. <https://doi.org/10.17309/tmf.2022.1.19>

ЗВ'ЯЗОК МІЖ ФІЗИЧНИМИ ЗДІБНОСТЯМИ Й ОСНОВНИМИ РУХОВИМИ НАВИЧКАМИ ДІТЕЙ ДОШКІЛЬНОГО ВІКУ

Деян Міленкович^{1ABCD}

¹Університет Уніон – Нікола Тесла

Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 2 табл., 66 джерел.

Метою цього дослідження було визначити взаємозв'язок між фізичними здібностями та основними руховими навичками дітей дошкільного віку. Метою також було визначити відмінності спостережуваних змінних у зв'язку зі статтю.

Матеріали та методи. Учасниками тестування успішно стали 52 дитини дошкільного віку: 30 хлопчиків і 22 дівчинки. Використовували п'ять тестів на фізичні здібності (модифікований тест на спритність «Т» (MAT), тест на стрибки в довжину, тест на збереження рівноваги в положенні стоячи, тест на присід і тест на підйом тулуба в сід із положення лежачи), а основні рухові навички оцінювали за допомогою Тесту розвитку великої моторики, 3-тє видання (TGMD-3). Для визначення впливу статі на результати фізичних здібностей та основних рухових навичок використовували однофакторний дисперсійний аналіз. Для визначення зв'язку між фізичними здібностями та основними руховими навичками використовували коефіцієнт кореляції Пірсона.

Результати цієї роботи показали в більшості випадків помірну та значущу кореляцію основних рухових навичок і параметрів фізичних здібностей як у загальній вибірці, так й індивідуально у хлопчиків і дівчинок ($p \leq 0,05$). Майже в усіх змінних фізичних здібностей і фундаментальних рухових навичок відзначена значуща різниця на користь хлопчиків ($p \leq 0,05$ та $p \leq 0,01$), за винятком тесту на збереження рівноваги в положенні стоячи, який показав, що значних відмінностей між статями немає ($p > 0,05$).

Висновки. Таким чином, можна дійти висновку, що одержана інформація може привести вчителів фізичного виховання до кращого розуміння зв'язків між змінними рухового статусу, що надалі дозволить їм ефективно працювати з дітьми, які завдяки правильному фізичному розвитку та вихованню стануть і залишаться фізично активними протягом усього життя.

Ключові слова: розвиток великої моторики, діти, спритність, сила, рівновага.

Information about the author:

Milenković, Dejan: dejan.milenkovic2309@gmail.com; <https://orcid.org/0000-0001-9341-0890>; Faculty of Sport, University Union - Nikola Tesla, Narodnih heroja 30/I 11070 Belgrade, Serbia.

Cite this article as: Milenković, D. (2022). Relation Between Physical Abilities and Fundamental Motor Skills in Preschoolers. *Physical Education Theory and Methodology*, 22(4), 561-568. <https://doi.org/10.17309/tmf.2022.4.15>

Received: 20.10.2022. Accepted: 09.12.2022. Published: 23.12.2022

This work is licensed under a Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0>).