

Comparative analysis of fundamental motor skills in preschool children: A cross cultural study of Bosnia & Herzegovina and Germany

SENAD MEHMEDINOVIĆ¹, MONOEM HADDAD², ZLATAN AGANOVIĆ³, KENAN KENDIĆ⁴, EDINA ŠARIĆ⁵, VESNA BRATOVIĆ⁶

^{1,5,6}Faculty of Education and Rehabilitation, University of Tuzla, BOSNIA and HERZEGOVINA

²Physical Education Department, College of Education, Qatar University, Doha, QATAR

³Independent researcher

⁴Kindergarten “Mainkrokodile GmbH, Frankfurt“, GERMANY

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Abstract

Fundamental motor skills are the foundation of individual motor development and are very important for the later specialization of skills, as well as for physical activity. These skills are developed in children regardless of gender, because they are the basic skills of motor development. However, the way in which fundamental motor skills are developed in children can differ with respect to gender and geographical region. This research aimed to assess the fundamental motor skills of preschool-aged children from Bosnia and Herzegovina and Germany, investigating whether geographic region and gender, as dichotomous variables, influence these skills. The study involved 79 children aged 3 to 7 years (both gender) with 39 from Bosnia and Herzegovina and 40 from Germany. The Test of Gross Motor Development (TGMD-3) was utilized for validation, and a two-way analysis of variance was employed. The testing was conducted on every participant individually with the average testing time per participant ranging from 20 to 25 minutes. The assessments were video recorded. The results indicated cross-cultural differences in fundamental motor skills, with children from Bosnia & Herzegovina exhibiting superior performances in locomotion (‘Gallop’, ‘Jump’, ‘Hop’, ‘Skip’, and ‘Slide’) and ball skills (‘One-hand forehand strike of self-bounced ball’, ‘One-hand stationary dribble’, ‘Two-hand catch’, ‘Kick a stationary ball’, ‘Overhand throw’, and ‘Underhand Throw’). Conversely, children from Germany demonstrated better proficiency in the ‘Run’ and ‘Strike’ variables. In general, the obtained research results should encourage experts to stimulate balanced development of fundamental motor skills in children, which can affect their overall physical development.

Key Words: TGMD-3, locomotion, ball skills, geographic region.

Introduction

The development of gross motor skills is a very important component of a child's psychomotor development, because thanks to the abilities of a large group of muscles, the child discovers and explores his environment and comes into direct contact with objects from the environment. Motor development includes movement behaviors that are used to transport the body from one location to another and to project and receive objects, especially balls (Ulrich, 2000). Motor development from birth to adulthood is divided into several specific phases, and for the purposes of this research, the third phase, from the third year of life, which represents fundamental motor skills (FMS), is important. This phase of motor development includes the child's preschool period and early school age, and previous researches have shown that this period is the most sensitive for the development of motor skills (Sabo, 2002; Cvetković, Popović & Jakšić, 2007).

Fundamental motor skills are the basis for the development of complex motor skills that, unlike simple motor skills, include larger components of neuromotor fitness, FMS are gross and fine movement patterns; gross movement patterns involve large muscle groups and fine motor movement patterns involve the activation of smaller muscle groups (Webster et.al., 2019). FMS, also known as gross motor skills, are basic, goal-directed movement forms that may be combined and applied to more context-specific skills (Webster & Ulrich, 2017 according to Burton & Miller, 1998; Clark, 1994). FMS including locomotor and object control skills, are the building blocks for developing advanced, complex motor skills to be used in health-enhancing physical activities (Pitchford, Leung & Webster 2021 according to Logan, Ross, Chee, Stodden & Robinson 2018).

There are several instruments for assessing gross motor skills, and one of the most commonly used is test of Gross Motor Development – TGMD (Ulrich, 1985, 2000, 2018). The TGMD–3rd Edition is the latest version of the TGMD and in the TGMD 3 the object control subtest was renamed the ball skills subtest. Also, in the ball skills subtest, underhand roll was deleted and underhand throw was added.

The result of these changes is that there are six locomotor skills and seven ball skills with a total raw score of 100 (Ulrich, 2017). After the changes of the TGMD 2, the TGMD 3 was initially used in the United States. The evaluation of psychometric characteristics was done by Webster and Ulrich (2017). Reliability assessments found that correlations with age were moderate to large; ball skills had a higher correlation ($r = 0.47$) compared with locomotor skills ($r = 0.39$).

Internal consistency was very high in each age group and remained excellent for all racial/ethnic groups and both sexes. Test-retest reliability had high ICC agreements for the locomotor ($ICC = 0.97$), ball skills ($ICC = 0.95$), and total TGMD-3 ($ICC = 0.97$). Based on the validity assessments, confirmatory factor analysis (CFA) supported the acceptable construct validity of TGMD-3. In Bosnia and Herzegovina, Mehmedinović, Bratovčić, Kuduzović, Avdić and Kožljak (2021) determined the metric characteristics of TGMD-3. Based on this research results, the TGMD-3 has satisfactory reliability and internal consistency for children aged between 3 to 10 years. Mutual correlations confirm the homogeneity of the scale. The results of the confirmatory factor analysis show a partial agreement of the assumed model with the data. Other studies have also confirmed that the TGMD has satisfactory metric characteristics (Mohammadi et.al, 2019; Valentini et.al, 2017; Rintala et.al., 2017; Estavan et.al, 2017 etc.). Considering the fundamental motor skills are of great importance for preschool children, and that there is an assessment instrument with up to standard metric characteristics, it is not surprising there is a large number of studies dealing with this topic. So, for example, a certain number of studies dealt with examining the connection between fundamental motor skills and physical activity in preschool children (Fisher et.al. 2005, Williams et.al. 2008, Crane et.al. 2015, Cook et.al. 2019 etc). Some of the studies examined the gender differences in fundamental motor skills (Laukkanen et.al. 2014, Cliff et.al. 2009, Mehmedinović et.al. 2022 etc). The studies on assessment of fundamental motor skills are generally conducted with the purpose of establishing certain differences (gender differences, place of residence, type of disability, etc.) and correlation with physical activity, which ultimately results in providing a training program suggestion if there were evident anomalies after evaluation. Studies that dealt with the assessment of fundamental motor skills in relation with geographical region and cross-cultural differences occurred less frequently. Examples of those studies are Tepeli (2018), whose study dealt with the assessment of gross motor development of 3-7 years old children in different geographical regions, while other studies in relation with geographical region (Bardid et.al. 2015, Jansen et.al. 2019) dealt with motor skills in middle childhood/elementary school-aged children.

Considering the limited and reduced number of studies dealing with this topic, the emphasis of this study was to evaluate the fundamental motor skills in preschool children from Bosnia & Herzegovina and Germany, along with establishing if the geographical region and gender, as a dichotomous moderator variable, affect the fundamental motor skills in children.

Material & methods

Participants

The study included a total of 79 participants aged 3 to 7 years old. The total was split into two subtotals, and the first one consisted of 39 preschool children attending the “Montesori” preschool institution from Tuzla, Bosnia & Herzegovina, of which 16 children were male (41%) while 23 were female (59%). The other subtotal of 40 children were attendees of “Mainkrokodile GmbH” preschool institution from Frankfurt, Germany, and it consisted of 16 male (40%) and 24 female participants (60%). Our study followed the principles of the Declaration of Helsinki.

Measuring instruments

With the intent of validating the established objective of the study, the assessment test (Test of Gross Motor Development; TGMD-3) was applied, the third and latest edition (Ulrich, 2018). The test comprises of 13 assessment variables split into two subtests. The first subtest measures locomotion and the second subtest measures ball skills. The skills assessed in the loco motor subscale include run, gallop, hop, skip, horizontal jump and slide. The ball skills evaluated include two hand strike of a stationary ball, one-hand forehand strike of self-bounced ball, one-hand stationary dribble, two-hand catch, kick a stationary ball, overhand throw and underhand throw.

Protocol

The research was conducted in Tuzla, Bosnia & Herzegovina and Frankfurt, Germany. Before testing, the educator/rehabilitator, who was the person conducting the research at the same time, was theoretically and practically educated on the application of assessment test (TGMD-3). The testing was conducted individually on every participant with the average testing time per participant ranging from 20 to 25 minutes. Furthermore, ahead of testing, the educator/rehabilitator prepared the material necessary for the assessment, as well as the room in which the assessment occurred. Assessments were video recorded.

Data processing methods

The data collected during assessments was processed using parametric statistical methods. Basic statistical parameters for measure of central tendency and measure of dispersion were calculated, and then completed with tabular and graphical presentation of data. The two-way analysis of variance was applied for validation of set objectives. The collected data was processed in SPSS 20 statistical package for Windows.

Results

Table 1. shows the measures of central tendency and the measures of dispersion compared to the individual subtest variables from the TGMD-3 assessment test. It is noticeable after analyzing the chart and observing the subtests, that the children from Bosnia & Herzegovina performed the best on the variables „Run“ (6,51±1,94) and „Horizontal jump“ (6,41±2,36), while they performed the worst on variables „Gallop“ (4.95±2,80) and „One hand forehand strike of self-bounced ball“ (3,03±2,59).

The children from Germany showed the best results on „Run“ (7,18±1,17), and „Two-hand strike of a stationary ball“ (7,58±2,67) variables, while the worst results came from „Gallop“ (3,45±2,51) and „One-hand stationary dribble“ (1,98±2,50) variables. In context of comparing the results of the two groups, it is evident from the research data that the children from Bosnia & Herzegovina achieved better scores in 11 different variables, while the children from Germany achieved better results in two variables. In order to inspect if the geographic region and gender contribute to statistically significant differences between the children from Bosnia & Herzegovina and Germany, and in relation to locomotion and ball skills subtests, the two-way analysis of variance was applied and the collected data was shown in the Table 2.

Table 1. Measures of central tendency and dispersion in relation to individual variables of the TGMD 3 test

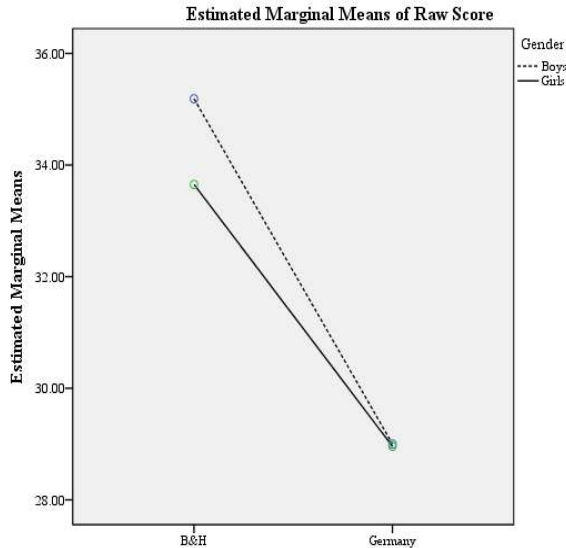
Subtest	Variable	Arithmetic mean	Standard deviation	Standard error	Minimum	Maximum
Locomotor (Bosnia and Herzegovina)	Run	6,51	1,94	0,31	1,00	8,00
	Gallop	4,95	2,80	0,45	0,00	8,00
	Hop	5,54	2,66	0,43	0,00	8,00
	Skip	5,05	1,34	0,21	1,00	6,00
	Horizontal jump	6,41	2,36	0,38	0,00	8,00
	Slide	5,82	2,58	0,41	0,00	8,00
Ball Skills (Bosnia and Herzegovina)	Two-hand strike of a stationary ball	4,80	2,51	0,40	0,00	8,00
	One hand forehand strike of self-bounced ball	3,79	2,61	0,42	0,00	8,00
	One-hand stationary dribble	5,28	1,21	0,19	1,00	6,00
	Two-hand catch	4,62	1,53	0,25	2,00	6,00
	Kick a stationary ball	5,64	2,57	0,41	0,00	8,00
	Overhand throw	5,82	1,89	0,30	1,00	8,00
	Underhand throw	5,69	1,85	0,30	2,00	8,00
Locomotor (Germany)	Run	7,18	1,17	0,19	4,00	8,00
	Gallop	3,45	2,51	0,40	0,00	8,00
	Hop	4,95	2,75	0,44	0,00	8,00
	Skip	3,68	1,89	0,30	0,00	6,00
	Horizontal jump	5,23	2,29	0,36	0,00	8,00
	Slide	4,50	2,73	0,43	0,00	8,00
Ball Skills (Germany)	Two-hand strike of a stationary ball	7,58	2,67	0,42	0,00	10,00
	One hand forehand strike of self-bounced ball	3,03	2,59	0,41	0,00	8,00
	One-hand stationary dribble	1,98	2,50	0,39	0,00	8,00
	Two-hand catch	2,15	1,49	0,24	0,00	4,00
	Kick a stationary ball	4,65	2,03	0,32	0,00	8,00
	Overhand throw	4,03	1,91	0,30	0,00	8,00
	Underhand throw	3,85	1,96	0,31	1,00	8,00

Based on the data collected and shown in the second chart, a conclusion can be drawn that the fundamental motor skills, namely locomotion and ball skills were affected by the geographical region of the examinee (p=0,026; p= i 0,001), while the gender as an independent dichotomous variable does not affect the fundamental motor skills. In other words, after observing the Chart No.2 and Graphs 1 and 2, the data suggests that children from Bosnia & Herzegovina on the level of statistical significance of 0,05 and 0,01 show better results in locomotion and ball skills in comparison with the children from Germany. Gender related results were considered statistically non-significant.

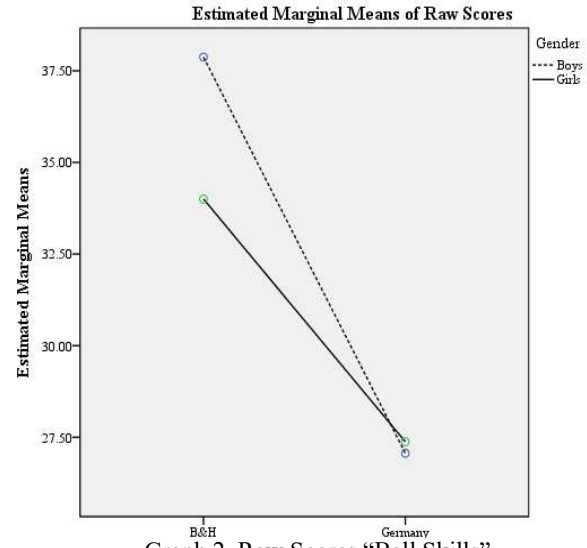
Correlation between geographical region and gender was statistically non-significant but the results can be interpreted in a way where both boys and girls from Bosnia & Herzegovina are showing better results in locomotion and ball skills in comparison to their peers from Germany (Graphs 1 and 2).

Table 2. Influence of geographic region and gender on motor skills

TGMD 3	Geographic region		Gender		Geographic region-Gender	
	F	p	F	p	F	p
Locomotion	5.12	.026	0.10	.744	0.09	.757
Ball Skills	13.19	.001	0.55	.460	0.76	.386



Graph 1. Raw Scores "Locomotion"



Graph 2. Raw Scores "Ball Skills"

Dicussion

The primary goal of this research was to evaluate whether there are differences in fundamental motor skills between children from Bosnia & Herzegovina and children from Germany, and additionally whether the geographic region and gender as dichotomous variables affect the gross motor skills of the examinees. In general, based on the collected data, it is noticeable that the children from Bosnia & Herzegovina showed better results in fundamental motor skills in comparison with the children from Germany, especially in 'Locomotion' subtest variables like 'Gallop', 'Jump', 'Hop', 'Skip' and 'Slide'. Namely, they showed better results on the 'Locomotion' subtest variables that involve motor skills that children perform to move from one point to another point in the physical environment (Tsikata et.al.,2021) and involve navigating the body through space with specialized movement (e.g. symmetrical, asymmetrical, lateral) (Clark et.al., 2002; Heywood et.al., as cited in Webster et.al., 2019).

The children from Germany showed better results on the 'Run' variable. When it comes to 'Ball skills' subtest variables, the children from Bosnia & Herzegovina performed better than children from Germany in 'One hand forehand strike of self-bounced ball', 'One-hand stationary dribble', 'Two-hand catch', 'Kick a stationary ball', 'Overhand throw' and 'Underhand Throw' variables. Considering the capacity required to perform these motor skills it is evident that the children from Bosnia & Herzegovina showed better results on variables that involve the manipulation of items either by projecting them away or receiving them and stability skills that involve the stabilization of the body's center of gravity. The children from Germany performed better on the 'Strike' variable. What is most noticeable is that both the children from Bosnia & Herzegovina and Germany performed the best on the 'Run' variable on the 'Locomotion' subtest.

This is not surprising since running is the integral part of child's plays and their daily activity. The children performed the worst on the 'Gallop' variable of the 'Locomotion' subtest. This is quite surprising since galloping as a motor skill includes a number of moves that should be at an advanced level in preschool children. The reason for this poor performance can be based on a premise that the activities and plays that improve this skill are not encouraged enough in preschool institutions, which is a separate topic that requires a more detailed and thorough research. When observing the overall 'Locomotion' and 'Ball skills' subtest results it is evident that the children from Germany performed worse in comparison to their peers from Bosnia & Herzegovina. This gap and dissimilarity can be attributed to the changes of lifestyle in recent years, namely in reduced physical activity in children. The way children spend their time nowadays presents an enormous issue since most of their free time is occupied with playing video games, watching television, excessive usage of computers and smartphones (Škovran et.al., 2020). Sedentary lifestyle is one of the biggest challenges and obstacles of present

time, for both children and adults, as it directly and negatively affects the time intended for physical activities. Unfortunately, the number of people that lack physical activity and consume low quality fast food is getting larger, and at the same time the children are being overly protected and encouraged to stay indoors, preventing them from experiencing open and healthy outdoor environment with physical activity and games that would benefit their health and development (Paulić, 2018).

There are available studies that assessed motor skills in children in different countries. And so the results of the “Motor ability and working memory in Omani and German primary school-aged children” study have shown a lower performance in the Total Motor Score of the Omani children compared to the German children (Jansen et.al., 2019). The researchers explain these differences in results through the fact that children in Oman do not play many games where it is important to react quickly, because of the high temperature or the social norms (Jansen et.al., 2019). The gross motor skill assessment between different geographical regions using the TGMD-2 assessment test was conducted in Turkey (Tepeli, 2018).

The results showed that there were no significant differences between the motor development of children in different geographical regions in Turkey. As conclusion, the author of the study stated: “In order to demonstrate to what extent the conditions of the experience and the possibilities offered to the child affect the motor development of children, there is a need for studies comparing the samples with different environmental factors such as physical living conditions, socio-economic level, and nutrition habits”. These three moderating variables (living conditions, socio-economic level and nutrition habits), as well as some additional variables (physical activity, anthropometric landmarks, access to informational technology, etc.) can probably be the predictors of better or worse, or in another words, advanced or underdeveloped motor skills – a topic that requires an additional and more detailed research.

Conclusions

The results of the research show that there are cross-cultural differences in fundamental motor skills in children aged between 3 to 7, where the children from Bosnia & Herzegovina performed better in locomotion and ball skills compared to the children from Germany. The results also showed that the boys from Bosnia & Herzegovina have better ability in locomotion and ball skills compared to the girls from Bosnia & Herzegovina, while the boys from Germany performed better in locomotion, but at the same time, performed slightly worse in ball skills in comparison to the girls from Germany.

In general, the obtained research results should encourage experts to stimulate balanced development of fundamental motor skills in children, which can affect their overall physical development. Although this study showed that there does not exist statistically significant impact of gender on fundamental motor skills, the results on individual variables show existing differences. Therefore, it is recommended that during preschool and early school ages (up to 10 years of age), children should be involved in activities that encourage the development of fundamental motor skills. In preschool age, there should not be found gender stereotypes, i.e. for the motor development, both girls and boys should have equal access to activities that develop locomotor skills and object control.

As a limitation of this research, the sample of respondents can be responded. Even though sample was selected by the method of random selection, it cannot fully represent the observed regions.

Conflicts of interest - There is no conflicts of interest to declare.

References:

- Bardid F, Rudd JR, Lenoir M, Polman R and Barnett LM (2015). Cross-cultural comparison of motor competence in children from Australia and Belgium. *Front. Psychol.* 6:964. doi: 10.3389/fpsyg.2015.00964
- Branta, C., Haubenstricker, J., & Seefeldt, V. (1984). Age changes in motor skills during childhood and adolescence, *Exercise & Sport Sciences Reviews*, 12: 467–520.
- Burton, A.W., & Miller, D.E. (1998). *Movement skill assessment*. Champaign, IL: Human Kinetics.
- Clark JE, Metcalf JS (2002). *The mountain of motor development: a metaphor*. In: Clark JE, Humphrey JH, editors. Motor development: research and 120 E.K.
- Clark, J.E. (1994). *Motor development*. In V.S. Ramachandran (Ed.), *Encyclopedia of human behavior* (Vol. 3, pp. 245–255). San Diego, CA: Academic Press.
- Cliff D.P., Okely A.D., Smith L.M., McKeen K (2009). Relationships between fundamental movement skills and objectively measured physical activity in preschool children. *Pediatr. Exerc. Sci*;21:436–449. doi: 10.1123/pes.21.4.436.
- Cook C.J., Howard S.J., Scerif G., Twine R., Kahn K., Norris S.A., Draper C.E (2019). Associations of physical activity and gross motor skills with executive function in preschool children from low-income South African settings. *Dev. Sci*;22:e12820. doi: 10.1111/desc.12820. [[PubMed](#)] [[CrossRef](#)] [[Google Scholar](#)]

- Crane J.R., Naylor P.J., Cook R., Temple V.A (2015). Do Perceptions of Competence Mediate the Relationship Between Fundamental Motor Skill Proficiency and Physical Activity Levels of Children in Kindergarten? *J. Phys. Act. Health*;2:954–961. doi: 10.1123/jpah.2013-0398. [PubMed] [CrossRef] [Google Scholar]
- Cvetković, M., Popović, B. i Jakšić, D. (2007). Razlike u motoričkim sposobnostima predškolske dece u odnosu na pol. U N. Smajlović (ur.), *Zbornik naučnih i stručnih radova II međunarodnog simpozijuma: Nove tehnologije u sportu*, Sarajevo: Fakultet sporta i tjelesnog odgoja: 288–293.
- Estevan I, Molina-García J, Queralt A, Álvarez O, Castillo I, Barnett L (2017). Validity and Reliability of the Spanish Version of the Test of Gross Motor Development–3. *J Mot Learn Dev*; 5: 69–81.
- Fisher A., Reilly J.J., Kelly L.A., Montgomery C., Williamson A., Paton J.Y., Grant S (2005). Fundamental movement skills and habitual physical activity in young children. *Med. Sci. Sports Exerc*;37:684–688. doi: 10.1249/01.MSS.0000159138.48107.7D. [PubMed] [CrossRef] [Google Scholar]
- Haywood K, Getchell N (2014). *Lifespan motor development*. 6th ed. Chicago, IL: Human Kinetics.
- Jansen P, Scheer C, Zayed K (2019) Motor ability and working memory in Omani and German primary school-aged children. *PLOS ONE* 14(1): e0209848. <https://doi.org/10.1371/journal.pone.0209848>
- Laukkanen A., Pesola A., Havu M., Sääkslahti A., Finni T (2014). Relationship between habitual physical activity and gross motor skills is multifaceted in 5-to 8-year-old children. *Scand. J. Med. Sports*;24:102–110. doi: 10.1111/sms.12116.
- Logan SW, Ross SM, Chee K, Stodden DF, Robinson LE (2017). Fundamental motor skills: a systematic review of terminology. *J Sports Sci*; 36:781–96. doi: 10.1080/02640414.2017.1340660
- Mehmedinović, S., Bratovčić, V., Kuduzović, E., Avdić, B., Kožljak, L. (2021). Metric characteristics of the Test of gross motor development (TGMD 3). *Research in Education and Rehabilitation*; 4(2): 146-155. <https://rer.ba/index.php/rer/article/view/25/13> DOI 10.51558/2744-1555.2021.4.2.146
- Paulić, M. (2018). Tjelesno vježbanje djece rane dobi : Diplomski rad (Diplomski rad). Preuzeto s <https://urn.nsk.hr/urn:nbn:hr:189:984633>
- Pitchford EA, Leung W, Webster EK (2021). Fundamental Motor Skill Delays in Preschool Children With Disabilities: 2012 National Youth Fitness Survey. *Front Public Health*; 7:9:758321. doi: 10.3389/fpubh.2021.758321. PMID: 34957017; PMCID: PMC8696669.
- Rintala PO, Sääkslahti AK, Iivonen S (2017). Reliability Assessment of Scores From Video-Recorded TGMD-3 Performances. *J Mot Learn Dev*; 5: 59–68.
- Sabo, E. (2002). Struktura motoričkog prostora i razlike u motoričkim sposobnostima dječaka predškolskog uzrasta pri upisu u školu. *Fizička kultura*, 56 (1-4), 10
- Senad Mehmedinović, Farzad Mohammadi, Hurma Begić, Edina Šarić, Naida Morić, Amela Sinanović (2022). [Assesment of fundamental motor skills in boys and girls](https://doi.org/10.51558/1840-4561.2022.19.1.43). *International Journal of Kinesiology*; Tuzla, 2022 Vol. 19, Issue 1. DOI 10.51558/1840-4561.2022.19.1.43
- Škovran, M., Cigrovski, V., Čuljak, K., Bon, I. i Očić, M. (2020). Razina tjelesne aktivnosti i dnevno sjedenje: čimbenici sedentarnog načina života kod mladih. *Hrvatski sportskomedicinski vjesnik*, 35 (1-2), 74-80. Preuzeto s <https://hrcak.srce.hr/250205>
- Tepeli, K. (2018). Comparison of Gross Motor Development of 3-7 Years Old Children in Different Geographical Regions. *Turkish Journal of Sport and Exercise*.
- Tsikata, E., Adomah Diaboh, C., & Eugenia Ama Aboagye, A. (2021). Assessing the Locomotor and Object Control Skill Levels of Basic Pupils in Ghana: The Role of Physical Education. *Universal Journal of Sport Sciences*, 1(1), 19–27. Retrieved from <https://www.scipublications.com/journal/index.php/ujs/article/view/115>
- Ulrich, D.A. (1985). *The Test of Gross Motor Development*. Austin, TX: PRO-ED Inc.
- Ulrich, D.A. (2000). *The Test of Gross Motor Development (2nd ed.)*. Austin, TX: PROED,
- Ulrich, D.A. (2018). *The Test of Gross Motor Development (3rd ed.)*. Austin, TX: PROED,
- Ulrich, D.A. (2017). Introduction to the Special Section: Evaluation of the Psychometric Properties of the TGMD-3. *Journal of Motor Learning and Development*, 5, 1-4.
- Valentini, N.C., Zanella, L.W., & Webster, E.K. (2017). Test of gross motor development– third edition: Establishing content and construct validity for Brazilian children. *Journal of Motor Learning and Development*, 5(1), 15–28. doi:10.1123/jmld.2016-0002
- Webster, E. K., & Ulrich, D. A. (2017). Evaluation of the psychometric properties of the Test of Gross Motor Development—Third edition. *Journal of Motor Learning and Development*, 5(1), 45–58. <https://doi.org/10.1123/jmld.2016-0003>
- 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>
- Williams H.G., Pfeiffer K.A., O'Neill J.R., Dowda M., McIver K.L., Brown W.H., Pate R.R (2008). Motor Skill Performance and Physical Activity in Preschool Children. *Obesity*;16:1421–1426. doi: 10.1038/oby.2008.214. [PubMed] [CrossRef] [Google Scholar]