

Metric characteristics of ball-handling skills tests for preschoolaged children



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Abstract

The aim of the research was to verify the metric characteristics of motor tests from the TGMD-2 test battery for assessing ball-handling skills in preschool-aged children. The level of ball-handling skills was checked with three tests (out of five possible) that form part of the battery for the assessment of gross motor skills based on the effective object control, namely: *hand dribbling in place*, *kicking the ball* and *catching the ball with two hands*. Tests *hit the ball with a bat with two hands* (hitting in baseball) and *throwing the ball* were omitted due to demanding rotational movement technique (according to the authors' estimate). The research was conducted on a sample of 30 children of whom 15 were girls and 15 boys aged 5 to 7 years. The results showed satisfactory metric characteristics of the tests and confirmed their possible implementation in further research in children of preschool age as well. The obtained results indicated the existence of a statistically significant gender difference in the test kicking the ball in favor of boys, but only for the first two attempts. The shortcoming of this study can be attributed to the relatively small number of participants. Also, there is very little possibility of comparing the results obtained in this study with the results of measurements in the Croatian population at this age due to the lack of research using tests from the TGMD-2 battery. Accordingly, the success of the acquired knowledge of children from this group cannot be defined, but their results can be an excellent reference point for possible further research of this type.

Key words:

children; motor knowledge; TGMD -2 test battery

Introduction

When working with preschool-aged children, one of the main tasks is to foster children's regular growth and development, and to satisfy their biological need for movement (Ivanščak & Loriger, 2018), whereby fostering their growth and development, as well as developing their traits and abilities, should be in accordance with their developmental characteristics and should respect their individual differences (Findak, 1995). The preschool age in children's lives is seen as the period of the most intensive motor development. Encouraging children to be physically active is one of the important aspects of their upbringing and education (Petrić, 2019) and is also important for fostering and creating habits that will lead to more physical exercise and generally creating positive life habits (Tomac, et. al., 2015). According to (Findak, et.al., 2011), there are few human activities that have such a significant effect on a person as physical exercise, which affects: the process of transformation of anthropological characteristics, acquisition of motor knowledge and raising the level of motor achievements. Natural movement is the most suitable for the exercise process with children because of the variety of activities it enables. The exercises for the acquisition and formation of motor knowledge in children must be interesting, refreshing and simple so that loss of motivation and satiety could be avoided. Enrichment of natural forms of movement is expected to decrease or even eliminate monotony and intellectual satiety in children (Loriger, 2014). In the entire process of growing up, it is paramount to pay attention to the acquisition of motor skills. Motor skills are all of the techniques learned for the purpose of performing certain movements or their combinations, which also include various sports techniques that are not necessarily related to motor skills but are more closely related to the child's cognitive abilities. However, motor skills are a prerequisite for high-quality execution of sports techniques, i.e. motor skills, so it is never too late to learn them. Learning motor skills takes place throughout one's life, so there is no need to focus too much on learning new ones (<https://mozes-ti-to.com/ucenje-motorickih-vjestina/>, 2023) i.e. they should not be piled on top of each other too quickly as it may overburden a child's cognitive capacities because the cognitive component is extremely important during their acquisition. Numerous studies have emphasized positive effects of physical exercise on children's motor learning. In the research by Ivanščak and Loriger (2018), the effects of motor learning on the distance ball throwing skill were examined on a sample of 52 preschoolers. Research results indicated statistically significant differences in the final measurement in both groups of respondents. The authors concluded that even a small number of repetitions can contribute to progress in a certain motor skill, and that motor learning has positive effects on children's motor development. In the research by (Gudelj Šimanović et. al., 2016), the analysis focused on the level of motor knowledge of preschool children who were included in various exercise programs. The research participants were 81 children divided into three subgroups. Their locomotor and manipulative motor knowledge were tested, and the results were statistically significantly better in favour of the children who attended a more varied sports program combined with a tennis playgroup. The obtained results indicated the importance of involving children in the sports activities that focus on several different sports with an emphasis on fun and play. Petrić (2019) states that from a kinesiology point of view, the early childhood and preschool period in a child's life is particularly relevant for the development of motor skills, morphological characteristics, and motor and functional abilities. The development of motor skills implies an individual's increasing ability to purposefully and harmoniously use one's own body to move and handle objects (Starc et al., 2004). Children's motor development from the age of five until they start school is marked by significant progress. This period is accompanied by an increase in strength and endurance, and the movements have become more precise and faster. The child can run quickly and connect running with other natural forms of movement, hit a target from

different distances as well as catch the ball thrown from different heights and distances (Petrić, 2019). The lack of this study can be associated with the relatively small number of participants. Also, there is very little possibility of comparing the results obtained in this study with the results of measurements in the Croatian population at this age due to the lack of research using tests from the TGMD-2 battery. Accordingly, the success of the acquired knowledge of children from this group cannot be observed, but their results can be an excellent landmark for possible further research of this type. The main objective of this research was to check the metric characteristics of three tests: hand dribbling in place, kicking the ball and catching the ball with two hands (the two-handed catch), using the TGMD-2 test battery intended for children aged 3 to 11 years.

Research hypotheses

This test battery measures children's locomotor mobility and the gross motor skills of effective ball throwing, kicking and catching (Ulrich, 1985), which are relevant for this research. The secondary objective was to check the skill levels in hand dribbling, kicking and catching the ball in this group of participants. In accordance with the defined objectives, the following hypothesis were set: the metric characteristics of the tests will be satisfactory (H1), and the level of ball handling skills will be satisfactory (H2).

Research methods

Participants

The research was conducted in June 2022, according to the Code of ethics in research with children, in three preschool groups in a kindergarten in Zagreb with a sample of 30 subjects (15 boys and 15 girls) aged 5 to 7 years.

Sample variables

To purpose of the research, three tests were used to examine the gross motor skill of handling the ball, namely hand dribbling in place, kicking the ball and catching the ball with two hands (Ulrich, 1985).

Ball handling skills tests

Hand dribbling in place

A ball, 20 to 25 cm in diameter, and a flat hard surface are required to perform the measurement.

Description of the measurement procedure

The subject stands in an upright position with one leg in a slight forward position while holding a ball in his or her hands. At the examiner's signal, the subject dribbles the ball in place three times with one hand. Three successful consecutive bounces count as one correct attempt. Correct execution involves contact with the ball with one hand at waist level, pushing the ball with the fingertips (slapping the ball with an open palm is not allowed) and pushing the ball with the hand on the front or the outer side of the same foot as the hand being used. The test is performed three times and is scored with one point if the subject has met all three criteria for successful performance. If the test taker does not meet one or more criteria, the attempt is not scored.

Kicking the ball

In order to carry out this test, a ball which is 20 to 25 cm in diameter, 9 meters of clean surface, an adhesive tape for marking the surface and a wall are needed.

Description of the measurement procedure

The examiner marks the 9-meter and the 6-meter distance from the wall with an adhesive tape, and places the ball on the line that is closer to the wall. The subject stands on the line that is 9 m away from the wall. At the examiner's signal, the subject should run and kick the ball hard against the wall. The correct performance implies a continuous and fast movement towards the ball, body tilted backwards when kicking the ball and a forward swing of the hand that is opposite to the leg with which the subject kicks the ball. The test is performed three times, and one kick of the ball signifies one measurement. If the subject meets all three criteria in one kick, the attempt is scored with one point, and if one or more criteria are not met, the attempt is not scored.

Catching the ball with two hands

A sponge ball which is 15 to 20 cm in diameter, 4 m of clean space and an adhesive tape to mark the surface are needed to carry out the test.

Description of the measurement procedure:

The tester uses the adhesive tape to mark two lines with a 4 m distance between them. During the test, the tester stands on one line and the subject on the other. The tester throws the ball using a two-handed underhand toss and makes sure that the ball is thrown between the subject's shoulders and waist. Correct execution of the catch implies the subject standing with the arms in front of the body and the elbows bent. While preparing for the contact with the ball, the subject extends his or her arms and at the moment of catching the ball with the hands, bends the elbows. The test is performed three times, and each catch of the ball is one measurement. A catch is scored with one point if the subject has met all three criteria for a successful performance, and if the subject does not meet one or more criteria, the attempt is not scored.

Data processing method

The analysis of the collected data was performed with Statistica 13.5. Basic descriptive parameters were calculated, and at the second level of analysis, the metric characteristics of the tests were checked, namely reliability coefficients and the factor structure. The following reliability coefficients were calculated: the alpha reliability coefficient (α), the correlation of individual items with the remaining test items (RMS), and the average inter-item correlation. The internal reliability coefficient of the tests (Cronbach's alpha, $C\alpha$) was also calculated, and the factor structure of the tests was verified.

Results

The obtained results (Table 1) show very low mean values (all are below 1.0), which indicates very weak ball handling skills in this group of preschool children. However, the arithmetic mean values for the final measurement in all tests demonstrate a quantitative improvement. This indicates that the increase in the number of repetitions has resulted in the adaptation of the test subjects to the performance of the task and their partial acquisition of the tested movement patterns. The value of the standard deviations (SD) indicates a relatively good homogeneity of the results, that is, a lower dispersion of the results, because in all three tests, in all attempts, the SD values are below 1.0. In conclusion, the achieved results show a lower level of ball handling skills than expected.

Table 1

Descriptive parameters for the variables - total sample (N=30)

VARIABLES		<i>M</i>	<i>Min</i>	<i>Max</i>	<i>SD</i>
Hand dribbling in place 1	1	0.30	0.00	1.00	0.47
Hand dribbling in place 2	2	0.47	0.00	1.00	0.51
Hand dribbling in place 3	3	0.60	0.00	1.00	0.50
Kicking the ball 1		0.57	0.00	1.00	0.50
Kicking the ball 2		0.70	0.00	1.00	0.47
Kicking the ball 3		0.73	0.00	1.00	0.45
Catching the ball with two hands 1	1	0.67	0.00	1.00	0.48
Catching the ball with two hands 2	2	0.70	0.00	1.00	0.47
Catching the ball with two hands 3	3	0.77	0.00	1.00	0.43

Legend: number of the participants (N), mean (M), minimum result (Min), maximum result (Max), standard deviation (SD)

The arithmetic mean values presented in Table 2 show quantitatively better results in the final measurement in all tests for both girls and boys. The results obtained for boys on the *kicking the ball* and *catching the ball with two hands* tests are better in the second measurement than in the final one.

Table 2

Descriptive parameters for the variables according to gender: girls (N=15) and boys (N =15)

Variables	M girls	M boys
Hand dribbling in place 1	0.20	0.40
Hand dribbling in place 2	0.33	0.60
Hand dribbling in place 3	0.47	0.73
Kicking the ball 1	0.33	0.80
Kicking the ball 2	0.47	0.93
Kicking the ball 3	0.60	0.87
Catching the ball with two hands 1	0.60	0.73
Catching the ball with two hands 2	0.53	0.87
Catching the ball with two hands 3	0.73	0.80

Legend: mean (M)

This may indicate a possible satiety with the performance or a drop in concentration in boys.

Test reliability coefficient

The results (Table 3) show a satisfactory level of reliability for the *hand dribbling in place* test and *kicking the ball* test in the item correlation values and the reliability coefficient alpha (α) that shows the movement of reliability after the omission of a single particle, as all values are above 0.80, which is considered the usual level of reliability. However, the test *catching the ball with two hands* did not show satisfactory properties in the coefficient (α). Only in the third attempt the alpha value approached the satisfactory level of reliability (0.76). Therefore, when using this test with preschool children, several attempts should be allowed, or the children should learn the structure of the motor task before the measurement so that the technique of the test performance and consequently test results may be reliable. The Cronbach's alpha value is also lower compared to the first two tests, but the average inter-item correlation is satisfactory. However, some authors believe that Cronbach's alpha values of 0.70, or even 0.60 can be considered satisfactory

(Griethuijsen et al., 2014 as cited in Taber, 2018).

Table 3

Reliability coefficients

Variables	RMS	α
Hand dribbling in place 1	0.70	0.86
Hand dribbling in place 2	0.85	0.72
Hand dribbling in place 3	0.71	0.85
Coefficient of internal reliability Cronbach's alpha ($C\alpha$)	0.87	
Average Inter-Item Correlation	0.70	
Kicking the ball 1	0.68	0.80
Kicking the ball 2	0.86	0.80
Kicking the ball 3	0.68	0.82
Coefficient of internal reliability Cronbach's alpha ($C\alpha$)	0.86	
Average Inter-Item Correlation	0.69	
Catching the ball with two hands 1	0.61	0.66
Catching the ball with two hands 2	0.65	0.61
Catching the ball with two hands 3	0.52	0.76
Coefficient of internal reliability Cronbach's alpha ($C\alpha$)	0.76	
Average Inter-Item Correlation	0.52	

Legend: correlation of an individual item with the remaining items (RMS), reliability coefficient movement of reliability after the omission of a single particle (α)

It can be concluded that Cronbach's alpha does not necessarily have to be viewed as a measure of an instrument, on the contrary, the values for Cronbach's alpha may be applied to a certain sample whose responses may be context-dependent and should not be assumed a fixed feature of the scale or an instrument (Taber, 2018).

Factorial structure of the tests

According to the results shown in Table 4 for each of the three tests, we isolated one factor with a value greater than 1.0, i.e. one main component.

Table 4

Results of the principal component analysis

VARIABLES	L	% Total	Cum %
1st test: Hand dribbling in place	2.34	77.89	77.89
2nd test: Kicking the ball	2.37	78.88	78.88
3rd test: Catching the ball with two hands	2.04	68.15	68.15

Legend: specific roots (L), total percentage (% Total), cumulative percentage (Cum %)

This shows that for each individual test there is a common measurement object, depending on the test structure: *hand dribbling in place factor* (test 1), *kicking the ball factor* (test 2) and *catching the ball with two hands factor* (test 3). Also, for all three tests, the level of saturation for the total variance for the isolated components is satisfactory. A slightly lower value obtained for the principal component is observed for *catching the ball with two hands* test, but it still has a satisfactory value (68.15%) and is close to the maximum value (100%).

Test item analysis

The results (Table 5) show very high values of items projected on each factor, which means that all three items in all three tests belong to the same object of measurement characteristic of the structure of each test.

Table 5

Results of the test item analysis

VARIABLES	Factor 1	Factor
Hand dribbling in place 1	-0.84	<i>Hand dribbling in place factor (F1)</i>
Hand dribbling in place 2	-0.94	
Hand dribbling in place 3	-0.87	
VARIABLES	Factor 1	<i>Kicking the ball factor (F1)</i>
Kicking the ball 1	-0.86	
Kicking the ball 2	-0.95	
Kicking the ball 3	-0.86	
VARIABLES	Factor 1	<i>Catching the ball with two hands factor (F1)</i>
Catching the ball with two hands 1	-0.84	
Catching the ball with two hands 2	-0.86	
Catching the ball with two hands 3	-0.77	

Although *catching the ball with two hands* test had a slightly lower level of internal reliability ($C\alpha=0.76$), which was explained earlier, its factor structure is satisfactory because the projections on the factor are higher than 0.70. Therefore, each isolated factor in each of the tests measures ball handling skills expressed through *hand dribbling in place*, *kicking the ball*, and *catching the ball with two hands*. Accordingly, the isolated factors (depending on the structure of each individual test) can be called the *hand dribbling in place factor (F1)*, *kicking the ball factor (F1)* and *catching the ball with two hands factor (F1)*.

Discussion

The aim of this research was to examine the level of gross motor skills of handling the ball using three tests for dribbling, kicking and catching the ball. In addition to the main goal, secondary goals were set, namely, to verify the metric characteristics of the tests from the TGMD-2 battery (Ulrich, 2000) on our population and to verify the significance of differences in the performance of the tests based on gender. The analysis of the obtained results has shown a quantitative improvement in the final measurement on all three tests. It is proposed that even a small number of repetitions in preschool age can result in visible progress with respect to specific motor movement, especially in view of the children's general lack of motor experience. Given that we did not find similar results for preschool-aged children in literature, comparison of the results is not possible, nor can the level of motor knowledge, that is, the skill of handling the ball, be defined as satisfactory. Accordingly, we can neither accept nor reject the second hypothesis (H2), which proposed that the level of ball handling skills would be satisfactory. The obtained results can be used to compare the level of ball handling skills in future studies, and that is the main value of this research. The obtained data further point to a clear need for increasing kinesiology activities in

educational institutions, which would have a positive impact on the overall development of children. This has been confirmed by previous research (Gudelj Šimanović et al., 2016; Ivanščak & Loriger, 2018), which also suggests that the improvement of motor knowledge is more viable in the environment where a multifaceted approach to the development of child's motor skills is implemented, with a higher number of repetitions of specific movement patterns. All this may have a positive effect on motor learning and consequently contributes to a more successful task performance. Verifying the metric characteristics of the ball handling skills tests showed very satisfactory results in this group of subjects for the *hand dribbling in place* test and *kicking the ball* test. Reliability analysis confirmed that these tests can be used in practice because the obtained values Coefficient of internal reliability Cronbach's alpha ($C\alpha$) were above 0.80 in all elements. As for the *catching the ball with two hands* test, given that it is a single-item test, its internal reliability values ($C\alpha = 0.76$) should be slightly better because in most research, the internal reliability limit Coefficient of internal reliability Cronbach's alpha ($C\alpha$) of 0.80 is considered desirable. Factor analysis showed that in all three tests, one measurement item that characterizes each test was isolated. Accordingly, it can be said that each test contains one measurement item that defines it. Factor loadings are high for all three tests and show that the factor structure corresponds to the *hand dribbling in place factor*, *kicking the ball factor* and *catching the ball with two hands factor*. Hence, the first hypothesis (H1) was confirmed, i.e. the metric characteristics of the tests are satisfactory. The lack of this research can be linked to the relatively small number of participants as well as the small chance of comparing the obtained results due to the lack of research using tests from the TGMD-2 battery at this age. It is therefore necessary to conduct more research on the kindergarten population to create a database that could be an excellent reference point for possible further research of this type.

Conclusion

The level of these skills has not been defined due to the impossibility of comparison with previously obtained results on a similar population, so this research may be used as the basis for further implementation of these tests in research, comparison of results and definition of the level of the stated motor knowledge. The results of the verification of the metric characteristics of the tests extracted from the TGMD battery (*hand dribbling in place*, *kicking the ball*, and *catching the ball with two hands*) confirmed satisfactory metric characteristics and the possibility of their implementation in practice. Verification of the test on a significantly larger sample and on the entire battery of tests is recommended for future research.

References:

- Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16(3), 297-334. doi:[10.1007/bf02310555](https://doi.org/10.1007/bf02310555).
- Findak, V. (1995). *Metodika tjelesne i zdravstvene kulture u predškolskom odgoju*.

Findak, V., Prskalo, I., & Babin, J. (2011). *Sat tjelesne i zdravstvene kulture u primarnoj edukaciji*. Učiteljski fakultet Sveučilišta u Zagrebu.

Gudelj Šimanović, D., Vukelja, M., & Krmpotić, M. (2016). Razina motoričkih znanja djece

predškolske dobi uključene u različite programme vježbanja. In V. Findak (Ed.), *Zbornik radova 25. ljetne škole kineziologa Republike Hrvatske "Kineziologija i područja edukacije, sporta, sportske"* (pp. 344-348). Hrvatski kineziološki savez.

Ivanščak, A., & Lorger, M. (2018). Bacanje loptice u dalj u predškolskoj dobi-efekti motoričkog učenja. In L. Milanović, V. Wertheimer, & I. Jukić (Eds.), *Zbornik radova 16. Međunarodne konferencije Kondicijska priprema sportaša* (pp. 260-264). Kineziološki fakultet Sveučilišta u Zagrebu.

Lorger, M. (2014). Motoričko učenje u predškolskoj dobi. In I. Prskalo, A. Jurčević-Lozančić, & Z. Brajčić (Eds.), *Zbornik radova međunarodnog znanstvenostručnog skupa simpozija 14. Dani Mate Demarina "Suvremeni izazovi teorije i prakse odgoja i obrazovanja"*, Topusko (pp. 169-175). Učiteljski fakultet Sveučilišta u Zagrebu.

Petrić, V. (2019). *Kineziološka metodika u ranom i predškolskom odgoju i obrazovanju*.

Učiteljski fakultet Sveučilišta u Rijeci.

Starc, B., Čudina-Obradović, M., Pleša, A., Profaca, B., & Letica, M. (2004). *Osobine i psihološki uvjeti razvoja djeteta predškolske dobi (priručnik za odgojitelje roditelje i sve koji odgajaju djecu predškolske dobi)*. Golden marketing - Tehnička knjiga.

Taber, K. S. (2018). The Use of Cronbach's Alpha When Developing and Reporting. *Research*

Instruments in Science Education, 48(1273-1296). <https://link.springer.com/article/10.1007/s11165-016-9602-2>.

Tomac, Z., Vidranski, T., & Ciglar, J. (2015). Tjelesna aktivnost djece tijekom redovitog boravka u predškolskoj ustanovi. *Medica Jadertina*, 45(3-4), 97 - 104.

Urlich, D. A. (1985). *Test of Gross Motor Development*. Pro-ed.



Odgoj danas za sutra:

Premošćivanje jaza između učionice i realnosti

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Učiteljskoga fakulteta Sveučilišta u Zagrebu Suvremene
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Hrvatskom akademijom znanosti i umjetnosti

Metrijske karakteristike testova vještine baratanja loptom u predškolskoj dobi

Sažetak

Cilj istraživanja bio je provjera metrijskih karakteristika motoričkih testova za procjenu vještine baratanja loptom iz TGMD-2 baterije kod djece predškolske dobi. Razina vještine baratanja loptom provjerena je s tri testa (od 5 mogućih) koji čine dio baterije za procjenu grube motoričke vještine temeljene na učinkovitoj kontroli predmeta i to: vođenje lopte rukom u mjestu, udaranje lopte nogom i hvatanje lopte s dvije ruke. Izostavljeni su testovi udarac loptice palicom s dvije ruke (udarac u bejzbolu) i bacanje loptice zbog (prema procjeni autorica) zahtjevne rotacijske tehnike izvođenja gibanja. Istraživanje je provedeno na uzorku od 30 djece od čega je 15 djevojčica i 15 dječaka u dobi od 5 do 7 godina. Rezultati su pokazali zadovoljavajuće vrijednosti metrijskih karakteristika testova te potvrdili njihovu mogućnost korištenja za daljnja istraživanja kod djece predškolske dobi. Dobiveni rezultati upućuju na postojanje statistički značajne razlike u testu udaranja lopte nogom u korist dječaka, ali samo u prva dva pokušaja. Nedostatak ovoga istraživanja može se povezati sa relativno malim brojem sudionika. Također, vrlo je mala mogućnost usporedbe dobivenih rezultata u ovom istraživanju sa rezultatima mjerenja u hrvatskoj populaciji u ovoj dobi zbog nedostatka istraživanja pomoću testova iz TGMD-2 baterije. Sukladno tome, ne može se definirati uspješnost usvojenih znanja djece iz ove skupine, ali njihovi rezultati mogu biti izvrstan orijentir za moguća daljnja istraživanja ovoga tipa.

Ključne riječi:

djeca; motorička znanja; TGMD baterija testova

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