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METRIC CHARACTERISTICS OF THE MEASURING INSTRUMENT FOR COORDINATION ASSESSMENT

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Original research:

Abstract

The research was conducted to determine the metric characteristics of the test for assessing preschool children's coordination in sports gymnastics. On a sample of 28 children aged between five and six years with at least one year of experience in sports gymnastics, 8 standardized tests were applied to assess the motor abilities of children, and one test on the gymnastics trampoline. The metric characteristics of the test were calculated in the programming system *"Statistica 5.0"* and supplemented with the programs *"RTT.stb"* and "*RTT-KON.stb,"* which Dizdar (2001, based on Momirović et al. 1999) wrote and implemented in the programming language for multivariate data analysis *"STATISTICA BASIC."* The results showed good metric characteristics of the test on the trampoline, Reliability RTT = 0.963; Alpha = 0.963; Lamda6 = .950; Rho = 0.903; MSA = 0.99; AVR = 0.899, and Hom = 0.98. However, it is necessary to increase the number of tests and subjects in order to determine the factor validity of the measuring instrument so that the test can be applied with certainty in the selection of gymnasts.

Introduction

Measurement is a basic scientific procedure that deals with the theory of measurement pertaining to the field of applied mathematics. It studies the basic settings of measurement and procedures for determining the metric characteristics of measuring instruments. In the field of kinesiology, Bala (2007) states that measurement enables the monitoring of human anthropological characteristics, which is especially important for the selection process in a particular sport and the forecast of results. Vučetić (2010) shares the view and emphasizes that it is necessary to ensure the reliability and validity of measuring instruments; this is followed by the results of Kochanowicz, Boraczyńska & Boraczyński (2009), who indicate that it is essential to have valid and reliable results in the selection process. In the broadest sense, any operation may be considered as measurement if, following a complete and accurate set of rules, it allows an object belonging to a certain homogeneous set of objects to be associated with a designation or number relating to a particular property. In turn, each member of that set of objects, which differ in that property, can be differentiated, and every two members of that set, which are identical in that property, can be considered identical (Momirović, 1988). Based on the above relations, the classical measurement model assumes that the correlation between test items depends exclusively on the real results on these items so that it is possible to calculate the measurement characteristics of the test based on the item intercorrelation matrix. One of the most critical metric characteristics is reliability, which refers to various aspects of stability and consistency of results obtained with a measuring instrument (Mejovšek, 2008). In other words, according to the same author, a measuring instrument is reliable if it obtains the same results in repeated measurements or if it consistently measures the same object of measurement in all its parts (Mejovšek, 2008). Since most coordination assessment tests consist of multiple items, another vital characteristic of a measuring instrument is homogeneity. It defines the extent to which the result in a composite measuring instrument depends on only one object of measurement (Šoše & Radjo, 1998).

In its structure, gymnastics requires developed coordination on all its devices, which can be defined as the ability to integrate different movement manifestations into a temporally and spatially efficient performance of complex motor tasks (Gallahue and Ozmun, 2006). Prskalo (2004) defines it as the ability to control the movements of the body, i.e., the performance of complex motor tasks, where agility is defined as the ability to change the direction of movement, which includes lateral as well. Research by Kochanowicz, Boraczyńska & Boraczyński (2009) on

a sample of 18 gymnasts aged 7-9 years showed that motor coordination is an essential indicator for the individualization of the training program. Veličković, Aleksić-Veljković & Herodek (2013) also dealt with the problem of coordination assessment tests by exploring the metric characteristics of 19 coordination tests used in 8 countries on a sample of 112 boys aged 7.5 years. They used three modes of verification: 1 mode included 1 trial attempt and two measurements; the second included 2 trial attempts and 2 measurements, while the third mode included 1 trial attempt and 3 measurements. The authors stated that, according to the metric characteristics, all tests are suitable for selection and that the optimal way to use them is the most practical way with 1 trial attempt and 2 measurements. The gymnastics trampoline is a device that requires several motor skills. One of them is the coordination ability of balance. The association between trampoline jumping and balance has also been established in previous research, which was confirmed in a study by YA-Wei and Jing Quang (2011) in athletes aged 15-16 years, where the connection between trampoline jumping and static balance tests was established. Atligan (2013) found an impact of trampoline training on the development of balance but also explosive power in children aged 9 and 10 years, while Aragao et al. (2011) found an impact of training on the mini trampoline on stability in adults. Therefore, the question is whether alternating lateral jumps on a trampoline can assess children's coordination. The aim of the research is the construction and determination of metric characteristics of the test for the assessment of motor abilities in preschool children.

Methods

Sample of participants:

The sample of participants comprised 28 children between the ages of five and six years with at least 1 year of experience in sports gymnastics, all members of G.D. Osijek.

Sample variables:

The sample of variables consisted of:

1. three tramp jump test items. The task is performed on a large trampoline. In the middle of the trampoline are marked two parallel lines 60 cm apart, in front of the trampoline is a vertical stand, in the middle between the two lines.

Participant's starting position: the participant is standing on the trampoline in a two-foot stance, relaxed, next to the line, facing a vertically placed stand in front of the trampoline. *Task performance:* the participant's task is to jump over two parallel lines laterally (with one-leg, not two-leg jumps) after the initial sign, in such a way that, in each jump, the torso crosses the projection of a vertically placed stand in front of the trampoline. *Task duration*: the task is performed for 15 seconds, in three repetitions. *Examiner's position*: the examiner stands behind the vertically placed stand in front of the trampoline, facing the participant. *Result*: the result is the number of jumps performed over two lines in 15 seconds. The second sample of variables consisted of tests to assess motor skills:

Coordination and agility assessment tests: polygon backward (MPN); side steps (KUS); running with a change of direction (MTPS); *Repetitive power tests:* sit-ups (MPT); two-feet rope jump (MSPV). *Movement and speed assessment test:* foot-tapping (MTP). *Balance tests:* standing with one leg on the balance bench with eyes open (MRJO), standing with one leg on the balance bench with eyes closed (MRJZ)

Methods of data collection

Testing of motor abilities in children was conducted in 2007 in Osijek, during training. The measurement was performed according to the standardized procedure for the mentioned measuring instruments by two PE teachers with many years of experience. The testing was performed on three occasions in such a way that each teacher measured the same test.

Statistical analysis

The normality of data distributions, basic descriptive parameters, item intercorrelation matrix, and factor structure of the tramp-jump test were calculated with the aim of determining factor validity using the software system *"Statistica 5.0."*. The reliability of the test was also calculated with the software system *"Statistica 5.0,"* but supplemented with the programs *"RTT.stb"* and *"RTT-KON.stb"* written by Dizdar, D., 2001 (based on Momirović et al. 1999) and implemented in the programming language for multivariate data analysis *"STATISTICA BASIC."* The program *"RTT.stb"* enables the determination of the reliability of composite measuring instruments under the classical measurement model and the determination of reliability after transforming the results into the Harris and image metrics. The program *"RTT-KON.stb"* enables the calculation of the total result of participants in composite measuring instruments within the framework of the sum and average result of intact and standardized real metrics, and based on item condensation on the first main component within the real, image, and Harris metrics.

Results and discussion

Table 1. Basic descriptive parameters in the tramp-jump test.

	Mean	SD	Min	Max
Tramp-jump1	15.07	6.250	7.00	33.00
Tramp-jump2	16.53	6.177	8.00	31.00
Tramp-jump3	16.03	6.113	9.00	30.00

It is observable from Table 1 that there is no difference in nominal values between the items, nor is there a significant variation in the results around the arithmetic mean between the tests.

Table 2. Correlation matrix between the items on the tramp-jump test

	Tramp - jump1	Tramp -jump2	Tramp -jump2
Tramp-jump1	1.00	0.89	0.88
Tramp-jump2	0.89	1.00	0.92
Tramp-jump3	0.88	0.92	1.00

It is observable from the presented data that all items are highly correlated with each other; the lowest correlation coefficient is between items 1 and 3, but it is also statistically significant and very high.
Based on the item correlation matrix, the following reliability measures were calculated using the classical measurement model in this study using the program *"RTT.stb"* written in the programming language for multivariate data analysis "STATISTICA BASIC" (Dizdar, 1999).

Table 3. Correlation matrix between the items on the tramp-jump test

RTT	0.964
Alpha	0.964
Alpha 1	0.413
Alpha 2	0.872
Lambda 6	0.950
Rho 1	0.903
Rho 2	0.997
Tau	0.902
MSA	0.994
AVR	0.899
Hom 1	0.983

The tables show that the RTT test values, as well as Kaiser Cafrey Alphe and Lambde6 values, are very high; a slightly lower Lambde6 value is more noticeable than RTT and Alpfa. However, it is still very high and it can be argued that the tramp-jump test is reliable.
The results obtained after analyzing each item are presented in Table 4.

Table 4. Reliability coefficients of each item on the tramp-jump test

	SMC	H1	RTT	Alpha	MSA	AVR
Tramp-jump1	0.820	-0.957	0.960	0.960	0.978	0.922
Tramp-jump2	0.881	-0.972	0.936	0.936	0.950	0.880
Tramp-jump3	0.67	-0.977	0.344	0.944	0.956	0.894

Table 5. Correlation matrix of measuring instruments

	MKUS	MTPS	MTP	MPT	MSPV	MRJO	MRJZ	TURAM-JUMP
MKUS	1.00	0.64*	0.37	0.48*	0.50*	0.44*	0.29	0.25
MTPS	0.64*	1.00	0.45*	0.53*	0.62*	0.36	0.13	0.25
MTP	0.37	0.45*	1.00	0.35	0.37	0.02	-0.08	0.01
MPT	0.48*	0.53*	0.35	1.00	0.47*	0.14	0.03	0.43*
MSPV	0.50*	0.62*	0.37	0.47*	1.00	0.34	0.38*	0.35*
MRJO	0.44*	0.36	0.02	0.14	0.34	1.00	0.60*	0.23
MRJZ	0.29	0.13	-0.08	0.03	0.38*	0.60*	1.00	0.29
TRAMP -JUMP	0.25	0.25	0.01	0.43*	0.35	0.23	0.29	1.00

The distribution of the results obtained with the tramp-jump test was tested using the Kolmogorov-Smirnov test. In all three items, the distribution of results proved to be normal. In other words, it did not deviate significantly from the normal data distribution. This research aimed to determine the metric characteristics of the tramp-jump test on a trampoline. Reliability coefficients Momirović's RTT (0.96), Guttman's Lamda6 (0.95), and Kaiser Cafrrey's alpha (0.96) show that the test is reliable, representative, and homogeneous. Although it structurally contains lateral left-right movements in a short period, it can be observed from the correlation matrix that the test results are mostly related to the results in the repetitive power test (MPT) and the two-feet rope jump test (MSPV), which contains lateral movements. Pejčić (2005) also states that the two-feet rope jump test is intended to assess the repetitive leg power.

Conclusion

The results of the measuring instrument for the assessment of coordination in preschool children on a gymnastics trampoline showed a high level of reliability, sensitivity, and homogeneity of the test. However, to obtain a better insight into the test's very factor structure, it is necessary to increase the number of participants and tests in order to assert the validity of the measuring instrument, which would enable a better selection of young gymnasts.

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