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DRAFT BATTERY OF TESTS FOR EVALUATION OF MOTOR ABILITIES IN 6 YEARS OLD CHILDREN

(Original scientific paper)

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Abstract

The aim of this paper is to suggest a battery of tests for evaluation of motor abilities in children. The research is conducted at sample of 123 examinees, 6 years old male children, pupils in first grade in five primary schools in Skopje, Republic of Macedonia. They were tested in 33 motor tests, hypothetically used for estimation of nine motor abilities. Adequate statistic procedures and methods were used in order to determine test`s discriminativity, reliability, validity and representativity. According obtained result, a battery of 16 motor tests with significant metric characteristics it`s proposed as adequate for further use in evaluation of children`s motor abilities.

Keywords: *physical education, motor tests, tests characteristics, Hotelling procedures, discriminativity, reliability, validity, representativity*

INTRODUCTON

The structure of motor space at children in a preschool and early school ages as well as manners of estimation and following of children`s motor abilities are often researched issues in kinesiology nowadays. The space of motor abilities of young children is arranged differently than the motor space of the older children or adults. Therefore, creating a battery of motor tests relevant for young children in every age period, is essential for further successful estimation of children`s motor abilities as well as establishment of battery of tests appropriate for following of children's motor achievements and revision of effects of realization of physical education classes.

Tests characteristics should be examined using proper methodology procedures and recommendations of previous researchers should be considered in every study that is conducted with children in different age period.

The authors Ikeda & Aoyagi (2007) reported that it is difficult to design a test of motor ability for young children that has sufficient reliability, validity, objectivity and practicality because young children have no understanding of time, no sense of rivalry (Matsuda, 1961, as cited in Ikeda & Aoyagi, 2007), and do not notice differences in their abilities to perform certain motor tasks. Difficulties in realization of measurements of children's motor abilities are also reported in researches conducted by Bala, 1999; 2007; Rajtamer, 1997; Popeska, 2009, 2011.

In Republic of Macedonia does not exist a recommended battery of motor tests that could be used for estimation and following of motor abilities in young children. These luck initiated the idea of this paper. Its main goal is to suggest a battery of tests with satisfy "Test Characteristics" suitable for estimation of motor abilities and motor achievements of 6 - years old children, first grade pupils in primary education.

METHODS

The sample of subjects is consisted of 123 examinees, six - years old children, pupils in first grade in five primary schools in Skopje, Republic of Macedonia.

The examinees were tested in 33 motor tests, hypothetically used for estimation of following nine motor abilities: co-ordination, running speed, frequency of movement, explosive, repetitive and static strength, balance, flexibility and preciseness. Motor tests were selected based on children`s age and possibilities, results of previous researches as well as recommendations of researchers that previously explored this issue. The motor tests used in our research were previously used in different researches (Bala, 1981, 1999; Perić, D. 1991; Dukovski, 1984; Zurc, Pišot & Strojnik, 2005; Popeska, 2009, 2011) conducted with young children and author`s recommendations were implemented in the research procedure. Following motor tests were used:

1. co- ordination: co-ordination with stick (kopal). obstacle course backwards (kopon), two balls slalom rolling (kosl2), rolling with ball on floor (kotrt);

2. speed of running:10m running from flying start (bt10ls), running 4 x 10(bt4x10), cries – cross running 4 x 5м (btzmt);

3. frequency of movement: arm plate – tapping (bstar), one foot - tapping(bstan), both feet – tapping on wall (bstnz);

4. explosive strength: standing broad jump (essdm), throwing medicine ball 1 kg from standing position (esfmst), throwing medicine ball 1 kg from sitting position (esfmg) и 20m dash running (es20vs);

5. repetitive strength: modified pushups (rsskl), sit-ups(rsptr),trunk lift (psitr),hands pulling over the diagonal swedish bench (rsvkk);

6. static strength: bent arms hang (ssvzg), horizontal hold lying on stomach (sszlm), horizontal hold lying on back (sszlg);

7. flexibility: deep bend on bench (fldpk), both legs extension lying on bag (flrlg), legs extended forward bend on floor (flprp);

8. balance: walking on upturned swedish bench (raosk), standing on bench in width (rasks), standing on bench in length (raskd) and

9. preciseness: throwing circles on stick (piobs),throwing tennis ball in vertical goal with arm (pitet), throwing ball in horizontal goal with arm (pithc), throwing ball in vertical goal with leg (pivcn), leading with short stick (pvgks),leading with short stick (pvgkd).

The authors of the paper have the detailed description of tests and procedure of measurement and estimation.

For composite tests used in the research, tests characteristics: sensitivity, reliability, validity and representativity were estimated. Sensitivity is calculated on bases of ratio between mean (X) and standard deviation (SD) (3:1). Crombah α и Spearman – Brown (SB) coefficients are used for estimation of reliability (According Bukvič, 1982, coefficients for reliability that are larger than 0.80 are considered significant and points out on high reliability). Validity of motor tests is calculated using Pearson`s – coefficient of correlation (r), the value of characteristic roots, factor scores of projections of isolated factor and communalities using Hotelling procedures (internal validity, validity between items from same test is satisfy when values are higher or equal at 0.80), while Kaiser-Meyer-Olkin`s measure is used for estimation of reliability and representativity (coefficients around **.**90 represent excellent reliability, around .80 very good reliability; around .70 good reliability; around .60 middle reliability; around .50 bad reliability and coefficients under .50 represent not satisfactory level of reliability).

RESULTS AND DISCUSSION

According psychometric beliefs, reliability, validity and representativity could be tested only for tests where activity is repeated two, three or more times or at so called composite tests. Tests for estimation of repetitive and static strength in this research are used with one repetition (one item test), therefore they were not considered in calculation for tests characteristics. These tests were used as one item tests because of certain functional and physical characteristics of 6 – years old children in a sense of unpreparedness for intensive and long-lasting strains (Gallahue, 1987, as cited in Age group development program, 1999), weak motivation and defocus from the goal and achievement (Rajtmajer, 1997) as well as findings for children disability for repeat maximal muscle activity. Coefficients for these characteristics obtained for other used tests are presented in separate tables. Because limited number of pages,

Table 1. Obstacle course backwards (KOPON), validity, reliability and representativity – 6 years old

Tests	r and SMC			H 1	h²
KOPON 1	(.75)			.94	.88
KOPON 2	.85	(.84)		.96	.93
KOPON 3	.84	.90	(.83)	.96	.92
Cronbach′s α	.95			Lambda	2,73
SB	.95			%	90,85
KMO	.77				

Table 2. *Characteristics of tests used for estimation of co – ordination*

Test	Discriminativity	Reliability		Validity				Represenativity
	Mean: SD	Cronbach`s α	SB	H 1 1	2	3	%	KMO
KOPAL	-	.92	.93	.91	.94	.95	87,33%	.75
KOPON	+	.95	.95	.94	.96	.96	90,85 %	.77
KOSL2	+	.94	.95	.93	.96	.96	90,12%	.76
KOTRT	+	.81	.81	.84	.87	.85	72,73%	.71

Table 3. Characteristics of tests used for estimation of speed of running

Test	Discriminativity	Reliability		Validity			Represenativity
	Mean: SD	Cronbach`s α	SB	H 1 **1**	**2**	%	KMO
BT10LS	+	.71	.73	.89	.89	78,56%	.50
BT4x10	+	.90	.90	.95	.95	90,80%	.50.
BTZMT	+	.85	.86	.94	.94	87,53%	.50

Table 4. Characteristics of tests used for estimation of frequency of movement

Test	Discriminativity	Reliability		Validity			Represenativity
	Mean: SD	Cronbach`s α	SB	H 1 1	2	%	KMO
BSTAR	+	.87	.87	.94	.94	88,65%	.50
BSTAN	+	.72	.72	.88	.88	78,11%	.50
BSTNZ	+	.91	.91	.96	.96	91,40	.50

Table 5. Characteristics of tests used for estimation of explosive strength

Test	Discriminativity	Reliability		Validity			Represenativity
	Mean: SD	Cronbach`s α	SB	H 1 1	2	%	KMO
ESSDM	+	.92	.92	.96	.96	92,60	.50
ESFMST	+	.77	.77	.90	.90	81,59	.50
ESFMG	+	.86	.86	.94	.94	87,86	.50
ES20VS	+	.74	.74	.89	.89	79,63	.50

Table 6. Characteristics of tests used for estimation of flexibility

Test	Discriminativity	Reliability		Validity				Represenativity
	Mean: SD	Cronbach`s α	SB	H 1				KMO
				1	2	3	%	
FLDPK	+	.98	.98	.97	.98	.98	95,24	.77
FLRLG	+	.96	.96	.95	.98	.96	92,75	.74
FLPRP	+	.97	.97	.95	.98	.97	93,51	.72

only one table for one test for coordination is presented as origin (Table 1). Other additional tables' contains only final results needed for result discussion.

Co-ordination. The tests: co – ordination with stick (KOPAL), Obstacle course backwards (KOPON), Two balls slalom rolling (KOSL2), Rolling with ball on floor (KOTRT) were used in the research for estimation of co – ordination. From four used tests, only one test co – ordination with stick (KOPAL) showed unsatisfied sensitivity. Other three tests have good sensitivity, examines achieved homogenous results positioned in the zone of lower values – good results.

According the values of Cronbach α и SB coefficient of reliability (Table 2) the used tests are *highly reliable*. Hotteling procedure conducted at the results of three repetitions at all four tests for co – ordination and one characteristic root was isolated and explains the variability of the system from 72, 73 % up to 90.85%. Highly explained variability points out that results from of three measures at all four tests for co – ordination so not differ significant which is confirmed with high and approximately same projections (from .91 to .96) at isolated factor. Homogeneity is also confirmed with high values of communalities (from .83 to .93) and the high coefficients of correlations between three repetitions (from .76 to .89), respectively high validity is obtained for all three measures.

The tests Rolling with ball on floor (KOTRT) is least reliable, representative and valid, but yet satisfactory in the whole group of tests. According the values of KMO measure of (from .71 to .77) tests for co – ordination used in the research has good representativity. Result analysis point out that tests applied at 6 – years old children used for estimation of co – ordination have satisfy test characteristics. Best characteristics are achieved for tests Obstacle course backwards (KOPON) and two balls

Table 7. Characteristics of tests used for estimation of balance

Test	Discriminativity	Reliability		Validity			Represenativity
	mean: SD	Cronbach`s α	SB	H 1 1	2	%	KMO
RAOSK	+	.92	.92	.96	.96	92,65	.50
RASKS	-	.81	.81	.92	.92	84,28	.50
RASKD	-	.78	.83	.92	.92	.92	.50

Table 8. Characteristics of tests used for estimation of preciseness with pitching

Test	Discriminativity	Reliability		Validity				Represenativity
	Mean: SD	Cronbach`s α	SB	H 1 1	2	3	%	KMO
PIOBS	-	.42	.42	.65	.57	.81	46,71	.51
PITET	-	.59	.59	.72	.77	.73	55,18	.63
PITHC	-	.63	.63	.77	.79	.71	57,57	.64
PIVCN	-	.63	.63	.63	.79	.85	57,74	.58n

Table 9. Characteristics of tests used for estimation of preciseness with leading

Test	Discriminativity	Reliability		Validity				Represenativity
	6 years	Cronbach`s α	SB	H 1 1	2	3	%	KMO
PVGKS	+	.74	.74	.81/.81.82	.81	.82	65,47	.69
PVGDS	+	.62	.62	.65/.80/.81	.80	.81	57,42	.61

slalom rolling (KOSL2) and they are recommended for further use with 6 years old children. Good characteristics for the tests Obstacle course backwards are also noted in the researches of Bala, 1999; Rajtmajer, 1997.

Speed of running. Runing speed was estimated using the following three tests: 10m running from flying start (BT10LS), running 4 x 10(BT4x10), Cries – cross running 4 x 5м (BTZMT). The proportion between mean and SD at tests used for estimation of speed of running satisfy the needed ratio 3:1, respectively the tests have good sensitivity (discrimiativity). Values obtained for validity, reliability and representativity (Table 3) points out on good tests characteristics. Best test characteristics are obtained for the test running 4 x 10(BT4x10), following by the test Cries – cross running 4 x 5м (BTZMT) and lowest but still satisfy characteristics are noted for the test 10m running from flying start (BT10LS). Lower values of KMO index (.50) point out on bad representativity of all three used tests. Therefore, because of the best test characteristics, the test Running 4 x 10(BT4x10) is recommended for further use in motor testing at 6 – years old children.

Frequency of movement. At all three tests used for estimation of frequency of movement: Arm plate – tapping (BSTAR), One foot – tapping (BSTAN) and Both feet – tapping on wall (BSTNZ), examined 6 – years old children achieved homogeneous results. Sensitivity is below recommended level only for the test Both feet – tapping on wall (BSTNZ). Obtained results (Table 4) for test used for estimation of frequency of movement point out on reliable, valid and representative tests, except the test One foot – tapping (BSTAN) that have lower and unsatisfied reliability (Cronbach′s α = .719, SB = .720) and bad representativity (.50).

The test both feet – tapping on wall (BSTNZ) has the best test characteristics, followed by the test Arm plate – tapping (BSTAR). Both tests are recommended as adequate for estimation of frequency of movement at 6 – year's old children.

Explosive strength is estimated using four movement tasks, realized with two repetitions: Standing broad jump (ESSDM), Throwing medicine ball 1 kg from standing position (ESFMST), Throwing medicine ball 1 kg from sitting position (ESFMG) и 20m dash running (ES20VS). Used tests are sensitive for differences of children`s achievements. Hotteling procedure was used on results of both measurements in all four tests used for estimation of explosive strength. One significant root was isolated and it explains the variability from 79, 63 % to 92.60%. Highly explained variability points out that tests result in both measures in all four tests do not differ significant. This is confirmed with high projections (from .89 to .96) on isolated factor. Obtained results (Table 5) point out on valid tests for estimation of explosive strength. High coefficients of reliability (.92 and .86) are obtained for the tests Standing broad jump (ESSDM) and throwing medicine ball 1 kg from standing position (ESFMST). Coefficients for reliability for other two

movement tasks: Throwing medicine ball 1 kg from sitting position (ESFMG) и 20m dash running (ES20VS) are below the level of significance. Consequently, best test characteristics are obtained for the test standing broad jump (ESSDM) used for estimation of explosive strength on legs and the tests throwing medicine ball 1 kg from standing position (ESFMST) used for estimation of explosive strength of the muscles extensors of the arms and shoulders and are recommended for further use with young children. Similar results are obtained in the research of Perić, (1991).

Flexibility is estimated using three movement tasks, realized with three repetitions: Deep bend on bench (FLDPK), both legs extension lying on bag (FLRLG), Legs extended forward bend on floor (FLPRP). For 6 years old children, used tests have shown as sensitive and easy to perform, except the test Legs extended, bend forward on floor (FLPRP) which was hard for children to perform. In all tests, children achieved homogeneous results. Results for test characteristics for flexibility tests are presented in Table 6. Obtained results point out on high reliable tests valued from .96 to .98. One factor is isolated using factor analysis. All tests have significant and high projections (from .95 to .98) on isolated factor what point out on high valid tests for flexibility. According obtained results, all three tests have good characteristics. Highest values for sensitivity, reliability, validity and representativity are noticed for the test Deep bend on bench (FLDPK) and it is recommended for further use with 6 years old children.

Balance. Following tests: Walking on upturned Swedish bench (RAOSK), Standing on bench in width (RASKS) and Standing on bench in length (RASKD) are used for estimation of balance and are performed with two repetitions. The proportion between mean and SD points out on bad sensitivity of used tests.Values presented in Table 7 points out on high coefficients of reliability (from .78 to .92) and high validity of applied tests. KMO index valued (.50) in all tests, suggest on tests with bad representativity. According obtained results, the test walking on upturned Swedish bench (RAOSK) is recommended for further use with 6 years old children and it`s classified as easier to perform compared with other two tests. Identical results are noted in research conducted by Perić, (1991) who recommended this test as appropriate for use with pre – school children.

Preciseness is estimated with six tests, four tests used for estimation of preciseness with pitching and two tests used for estimation of preciseness with leading. Tests used for preciseness with pitching: Throwing circles on stick (PIOBS),Throwing tennis ball in vertical goal with arm (PITET), Throwing ball in horizontal goal with arm (PITHC) and Throwing ball in vertical goal with leg (PIVCN) were hard to performed for 6 years old children and do not register differences between children`s achievements (low sensitivity). All four tests are shown valid with one isolated factor that explains the variability of the system with values from 46.71 % to 57, 74%. Values for Cronbach′s α coefficients from .42 to .63 are low and under the limit of significant. Same values from.42 to .63 are also obtained as for SB coefficient which points out on tests with lower and not significant reliability of the tests, respectively results are highly conditioned by the influence of other unsystematic factors (concentration, problems with vision, emotional distraction etc. Values of KMO index (from .51 to .68) points out on average level of representativity of selected tests.

Bad characteristics of the tests for estimation of preciseness with pitching could be explained with children's age and the nature of preciseness. Precisely, the individual tempo of growth, vision problems for certain examiners and general farsightedness of children at the age between 5 and 7 years (Gallahue, 1987, as cited in Age group development, 1999) could explain the variability and larger aberrance of results for these motor tasks. Findings for causality of preciseness from coordination eye – hand and eye – foot (Gajić,1985), children emotional condition and touchiness additionally explained the notices condition with preciseness. Because of insufficient synchronization between certain body parts and smaller procession of information, six years old children have not yet established eye – hand coordination (Gallahue, 1987, as cited in Age group development, 1999). Emotional condition has a great role in preciseness of performed movements. Children are emotional easy disturbing, especially in new and unknown situations (Gallahue, 1987) such as motor measurements. Therefore, emotional condition is a significant factor in variability of result in tests for preciseness.

Precisenes with leading is estimated using two tests: Leading with short stick (PVGKS).

Results for tests characteristic are presented in Table 9. One isolated factor with high projections valued from .65 to .81 point out o valid motor tests. Values for coefficients of reliability (.62 and .74), are lower or equal to the limit of significance which means unreliable tests. Values of KMO measure for representativity from .61 to .69 point out on good representativity of used tests. According obtained results, the test leading with short stick (PVGKS) is recommended for further use with 6 - year old children.

CONCLUSION

Summarizing all obtained results, the general conclusion is that applied tests are noted as tests with satisfy test characteristics for the sample of 6 - years old children. High reliability and validity obtained in number of used tests is also confirmed in researches with similar aim conducted by Perić, 1991; Rajtmajer, 1997; Bala, 1999; Popeska, 2009, 2011.

Certain notifications of authors that investigated characteristics of motor tests applied with young children correspond with notifications and results obtained in this research. In this since, the authors Ikeda & Aoyagi (2007) established that less reliable tests are more valid, which is confirmed in our research. Reliability on the margin or below the limit of significance could be explained

with children's motivation and their properness for total activation and participation I task's (Jürimae & Jürimae, 2001), emotional instability (Gallahue, 1987, as cited in Age group development program, 1999), defocus from the goal, understanding the testing process as game which is one of the major practical problems when applying motor tests and researches with children (Rajmajer, 1997). Knowing that children could not focus their attention on a same activity for a long time, certain actions such as motivation, demonstration and previous attempts of the movements, actions that are not acceptable in work with older subjects, could be justified and recommended in work with children (Bala, 1999; Jürimae & Jürimae, 2001). From these reasons, in these types of researches there is a need of studying of children's emotional and psychological development and there influence of motor abilities.

From the total number of 33 movement tasks used for estimation of nine motor abilities, according the values for validity, sensitivity, reliability and representativity, a short battery of motor tests was created and it is adequate for further application in researches and in education work with 6 years old children. Following tests with good test characteristics are recommended as a short battery for motor testing: (1) Obstacle course backwards - KOPON for co – ordination; (2) Running 4 x 10 - BT4x10 for running speed; (3) Both feet – tapping on wall BSTNZ and (4) Arm plate – tapping BSTAR for frequency of movement; (5) Standing broad jump ESSDM for explosive strength of legs and (6) Throwing medicine ball 1 kg from sitting position ESFMG for explosive strength of upper body parts; (7) Modified pushups RSSKL, (8) sit-ups RSPTR and (9) trunk lift PSITR, (10) Hands pulling over the diagonal Swedish bench RSVKK for repetitive strength; (11) Bent arms hang - SSVZG, (12) Horizontal hold lying on stomach - SSZLM and (13) Horizontal hold lying on back - SSZLG for static strength; (14) Deep bend on bench - FLDPK for flexibility; (15) Walking on upturned Swedish bench - RAOSK for balance; (16) Throwing ball in vertical goal with leg - PIVCN for preciseness with pitching and (17) Leading with short stick - PVGKS for preciseness with leading.

The main purpose of suggested battery of test is to facilitate the work of teachers and sports pedagogics in a since of estimation, evaluation and following of children's motor achievements. This is especially important knowing the tendency of structuring physical education programs in three segments (1) movement skills, (2) development of motor abilities and (3) socio – emotional development (Klinčarov & Popeska, 2011). Therefore, findings and suggestions from this research have a practical application in the segment of development of motor abilities and possibility for their precise measurement.

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