METRIC CHARACTERISTICS OF BALANCE TESTS FOR PRESCHOOL CHILDREN, AGE 5-6

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Abstract

The aim of this study was to determine the metric characteristics of five motor tests for assessing balance. Sample included preschool children at the age 5-6. The study included 53 children, 34 boys and 19 girls from Zagreb, Croatia. Measuring instrument consisted of five different motor tests: *Standing with one foot on the balance cube* (MRJK), S*tanding on one leg longitudinally on the balance bench with open eyes* (MRUO), *Standing on one leg longitudinally on the balance bench with eyes closed* (MRUZ), *Standing on two legs across the balance bench with open eyes* (MRPO) and *Standing with two legs across the balance bench with eyes closed* (MRPZ). Data of the tests were checked with descriptive statistics and metric characteristics of each test was proven: objectivity, sensitivity, reliability, homogeneity and validity. Results showed only one test *Standing with one foot on the balance cube* (MRJK) has satisfactory metric characteristic, and it is recommended for preschool teacher to use it when testing balance motor skill.

Key words: *balance; child; measurements, preschool teacher*

Introduction

The balance as a motor characteristic is a complex feature, since psychological, physiological and biomechanical components are integrated together. The ability to maintain balance in static or dynamic conditions is very important for successful implementation of a numerously human activities in daily life as well as the specific ones in programmed activities. (Tkalčić, 1987).

The problem of monitoring motor skills in preschool population lies in inadequate measuring instruments for preschool children with unsatisfactory metric characteristics of the same since most of those have been designed for adults or school population. The applied tests for assessment of the balance can be divided into two: tests for static and dynamic balance: like balancing on one or both feet on the balance bench (eyes can be open or closed), balancing on only one foot on the ground, walking along the line between the feet, walking on a line, on a gymnastics beam or on an elevated bench, etc. Using a large sample of 7-years-old Babin (1993) determined metric characteristic of the test for assessing the balance *Standing on the balance bench across with both legs with the open eyes*, and in results has obtained weak average value of the correlation between the particles. Then, in a sample of preschool children Horvat et al. (2008) have also tried to determine metric characteristic of three tests for assessing a balance. Two tests: *Standing with both feet transversely to the direction of the bench* and *Standing with one foot transversely to the direction of the bench* shown satisfactory metric characteristics while the third one *standing with one foot along the bench* shown something worse results. Same authors believe it would be justified to make certain changes in the construction of the tests, like so, to increase the standing surface of the instrument balance board. They assumed this change would probably improve metric characteristics of designed test. Hraski et al. (2015) used a sample of 4-year-olds and found that the test for assessing the balance *Walking on the narrowed field* has satisfactory metric characteristics and can be used for this age group when assessing the balance. Still, another test *Standing on one leg* showed a poor metric characteristics and they don't recommend it for assessing balance. Popeska et al. (2015) on a sample of 7-year-old used the test *Walking on upturned Swedish bench* and conclude, test can be recommended for future use for estimation of dynamic balance, while the test *Standing on a bench in width* has the best metric characteristics and could be recommended for future use when evaluating static balance in 7-year-old children.

The earliest childhood is the best time to start with different exercises when we talk about development of gross motor characteristic of balance. For adopting balance there are numerous games and exercises tailored and appropriate for preschool children. There are games of imitation and animals like movements, all exercises crossing along the benches, climbing and descending the slope, field games, different dances and dance structures, all kind of elements of rhythmic and sport gymnastics on the ground, ballet, etc. (Kosinac, 2011). The child's environment influence largely on one's motivation and the willingness to play and exercise what is necessary for the proper development of balance motor skill.

The aim of this study was to check the metric characteristics of five balance tests for children aged 5-6 years old and to produce recommendation for preschool teachers' when they perform testing in preschool institutions.

Methods

The research sample consisted of 53 preschool children (34 boys and 19 girls) from three different kindergarten groups in Zagreb, Croatia. Children were 5 - 6 years of age. For each child, it was obtained parents written consent according to Code of Ethics for Research with Children (Dulčić, 2003), which allow child's participation in research. At the time of data collection, no child had health problems or disease, and all were tested in the same conditions. Five different tests were used for purpose of this study. The first test was *Standing with one foot on the balance cube* (MRJK), second, *Standing on one leg longitudinally on the balance bench with open eyes* (MRUO), third, *Standing on one leg longitudinally on the balance bench with eyes closed* (MRUZ), fourth *Standing on two legs across the balance bench with open eyes* (MRPO) and the last *Standing with two legs across the balance bench with eyes closed* (MRPZ).

Results and Discussion

The basic descriptive statistics are shown in Table 1. Result values presented a significant dispersion of the results in all tests except the first one: MRJK - *Standing with one foot on the balance cube*. The coefficient of asymmetry (Skew) exposed a positive asymmetric distribution in all particles of tests which means the majority of respondents classify in areas of lower results with few extremely high values. Normality of distribution was tested with Kolmogrov-Smirnov (K-S) test. According to the K-S test, distribution of the results in seven variables do not deviate from the "normal" (p> .20) while in eight does. Only one variable MRJK - *Standing with one foot on the balance cube* in all three measurements had normal distribution of results and only for the one satisfactory sensitivity of the test can be determined (Table 1).

Table 1: The basic descriptive statistics of tests

	M	SD	Min	Max	Skew	Kurt	K-S	p
MRJK1	12.33	12.19	1.28	60.00	1.61	3.29	0.18	p< .10
MRJK2	13.13	13.45	1.82	60.00	1.74	2.90	0.21	p< .05
MRJK3	13.96	12.42	1.11	60.00	1.53	2.62	0.16	p< .15
MRUO1	2.96	1.19	1.24	7.03	1.16	1.90	0.11	p> .20
MRUO2	2.74	1.33	1.05	9.05	2.56	9.32	0.16	p< .15
MRUO3	3.10	2.02	1.13	13.26	3.11	12.46	0.25	p< .01
MRUZ1	2.13	0.93	0.84	5.91	1.73	4.15	0.19	p< .05
MRUZ2	2.24	0.78	0.94	4.04	0.64	-0.38	0.13	p> .20
MRUZ3	2.09	0.65	0.79	3.70	0.64	0.24	0.14	p> .20
MRPO1	2.24	0.84	0.52	4.67	0.33	0.46	0.05	p> .20
MRPO2	2.44	0.94	0.80	4.70	0.68	0.17	0.10	p> .20
MRPO3	2.19	0.86	0.98	6.37	2.34	9.82	0.14	p< .05
MRPZ1	1.89	0.75	0.75	5.30	1.91	7.05	0.13	p> .20
MRPZ2	1.90	0.57	0.95	3.83	1.30	2.92	0.12	p> .20
MRPZ3	1.95	0.66	0.73	3.98	0.93	0.75	0.14	p> .20

MRJK - 1st, 2nd, and 3rd measurement - Standing with one foot on the balance cube; MRUO - 1st, 2nd, and 3rd measurement - Standing on one leg longitudinally on the balance bench with open eyes; MRUZ - 1st, 2nd, and 3rd measurement - Standing on one leg longitudinally on the balance bench with eyes closed; MRPO - 1st, 2nd, and 3rd measurement - Standing on two legs across the balance bench with open eyes; MRPZ - 1st, 2nd, and 3rd measurement - Standing with two legs across the balance bench with eyes closed; The arithmetic mean (M), Standard deviation (SD), The minimum value (Min.), The maximum value (Max.), Coefficient of asymmetry (Skew), Coefficient of curvature (Kurt), Value of Kolmogrov-Smirnov test (KS), The value of significance (p)

Homogeneity is a property of the composite tests, explaining does the results of the respondents in all the particles depend on the same object of measurement or identical combinations of different items of measurement (Dizdar, 2006). The homogeneity of tests was calculated with correlation between the particles. High enough correlation between the particles from 0.61 to 0.71 was found only in the test MRJK - *Standing with one foot on the balance cube*, like shown in Table 2., while the other four conducted tests do not meet this metric characteristic.

Table 2: Correlation of the particles for the test MRJK - Standing with one foot on the balance cube

Variable	Correlation		
	MRJK1	MRJK2	MRJK3
MRJK1	1.000	0.611	0.713
MRJK2	0.611	1.000	0.704
MRJK3	0.713	0.704	1.000

Reliability of internal consistency is expressed through Crombach alpha. Only one test MRJK - *Standing with one foot on the balance cube* shown good metric characteristic with Crombach α 0.86, while Crombach α of remaining four tests range in the interval from 0.32 to 0.62 and do not meet the reliability of these tests (Table 3).

Table 3: Reliability of internal consistency expressed through Crombach alpha for all five test

variable	Cronbach alpha	Standardized alpha	Average inter-item corr
MRJK	**.860**	**.862**	**.678**
MRUO	.622	.628	.368
MRUZ	.528	.536	.279
MRPO	.466	.460	.225
MRPZ	.320	.319	.135

The validity of all five tests was determined by factor analysis. Rotation of the principal components in varimax position gave the two-factor structure of the analysed area (Table 4). The first factor has eigenvalue of 4.69 and explains 31.28% of the total variance of the analysed variables (Table 5). It is evident, the test MRJK - *Standing with one foot on the balance cube* described the strongest area of the first factor, thus confirming the validity of this test for use in pre-school, with children of 5 - 6 years of age.

Table 4: The principal components obtained by factor analysis – varimax position

variable	Factor 1	Factor 2
MRJK1	**0.772**	0.100
MRJK2	**0.850**	-0.018
MRJK3	**0.726**	0.093
MRUO1	0.510	0.433
MRUO2	0.710	-0.149
MRUO3	0.570	0.342
MRUZ1	0.694	0.129
MRUZ2	0.131	0.569
MRUZ3	0.386	0.342
MRPO1	0.363	0.345
MRPO2	0.235	0.467
MRPO3	-0.131	0.680
MRPZ1	0.596	0.089
MRPZ2	-0.031	0.693
MRPZ3	0.292	0.452
Explain variance	4.233	2.302
Total proportion	0.282	0.153

Table 5: Eigenvalues and percentage of total variance explained

	Eigenvalues	% total Variance	Cumulative Eigenvalues	Cumulative %
1	4.693	31.288	4.693	31.288
2	1.843	12.287	6.536	43.575

Results received of the proportion between mean and standard deviation acknowledge bad sensitivity of all used tests. Average values of tests are highest in the test MRJK - *Standing with one foot on the balance cube* which could be explained throughout wider foothold where children could hold out longer period of balance position in relation to other tests whose surface was narrower. The scatter of skewness values showed that all the tests are difficult to perform on the sample's age. Analysing the results for validity, reliability and representativeness of the tests, again only MRJK test - *Standing with one foot on the balance cube has good* metric characteristics. Similar result with low discrimination got

Popeska (2015) on a research sample of 7-years-old in the test *Walking on upturned Swedish bench* and *Standing on bench in width and in length* with also high validity and representativeness. In research sample of 6-years-old using the same tests Popeska (2014) communicate bad sensitivity but high reliability and validity of applied tests. In another research Ikeda and Aoyagi (2007) on a sample of preschool children explained how the test for assessing the balance (standing on a one foot and squat balance) are difficult for them, because it is hard for young children to find motivation while they perform what is related with their determination. Satisfactory discriminability is not found for the test *Standing on one leg* on research sample of 4-year-olds (Sindik, Horvat i Hraski, 2016) while different test *Walking on the plank* had good metric characteristics. Same, can be found in other researches (Perić, 1991; Popeska & Jovanova-Mitkovska, 2014; Hraski, Horvat & Bokor, 2016) where this test they recommend as consider appropriate for use with preschool children.

The concern of metric characteristics of different tests for assessing the balance in preschool population can be explained by research Foudriat et al. (1993) where it is explained how the same somatosensory-dominant postural control as in adults can be achieved in age of six, what leads to conclusion, development of standing balance can almost be finished in early school years. Morioka (2001) has reported that the ability to maintain the one-leg standing position with eyes open will dramatically improve in children within the period from late preschool age to early school age, and the improvement will slow down during late school age. Similar results described Figura et al. (1991) where suggests that around 8-years-of-age some static balance abilities have already been acquired, such as two-feet postures, but somewhat more difficult postures, such as standing on one foot only, are still in their major developmental phases.

Conclusion

Based on the results of the sensitivity analysis, and on the values of the asymmetry and curvature of distribution (skewness and kurtosis), it is possible to conclude that measuring instrument MRJK - *Standing with one foot on the balance cube* in all three measurement has a normal distribution, and the results can be concluded that only this test from five initially suggested is satisfactory sensitive. The condition of homogeneity in terms of the correlative relationship between the particles is also satisfied in the test MRJK - *Standing with one foot on the balance cube* while the Cronbach α of the same test was 0.86. From the above it can be also settled that the test MRJK - *Standing with one foot on the balance cube* showed factorial validity, and can be applied to estimate the static balance of preschool children in practice. As mentioned before, other four tests for assessing balance used in this research didn't showed satisfactory metric characteristics.

Limitation of the research refers to small research sample and limited geographical area, which in future research no doubt need to be expanded in both directions but staying strictly in the same age group.

The results for defining the metric characteristics of selected test for assessing balance will contribute to better programming of kinetic activities in preschool programs, monitoring motor development of children and can increase the quality of work of preschool teachers.

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