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Original research article

THE FACTOR VALIDITY AND RELIABILITY OF TESTS FOR THE EVALUATION OF JUMPING FREQUENCY

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Darko Stojanović, Dragana Berić, Nikola Stojanović

Faculty of Sport and Physical Education, University of Niš, Serbia

Abstract. *With the aim of studying the factor validity of the newly-constructed tests for the evaluation of jumping frequency, an experimental study was carried out on a sample of 25 volleyball players aged 20.20+3.16. To evaluate jumping frequency, four tests of single leg jump tests were applied (jumping on the left and right leg back and forth, lateral left and right leg jumps) and three double leg jump tests (double leg quick lateral bounds, lateral bounds and scissor jumps), as well as two tests for the evaluation of movement frequency, whose factor validity was already established (hand tapping and foot tapping). The results obtained from the participants in these tests had normal distribution and had satisfactory sensitivity. Using an Item analysis, a satisfactory reliability of all the applied tests of single and double leg jumps for the assessment of jumping frequency in the range of 0.92 to 0.81 was determined, and the conclusion drawn that the greatest coefficient of reliability (Cronbach alpha) was found for the Left leg jumps back and forth test, and the smallest for Double leg quick lateral bounds test. Using a factor analysis (the principal component method), the factor validity of the tests was determined, with coefficients ranging from -0,55 to -0,90, where the greatest projection on the first principal component originates from the left leg jumps back and forth, and the smallest from the double leg jumps to the side. On the basis of the results, we can conclude that all the tests of single and double leg jumps have satisfactory factor validity in the space of simple movement frequency for this sample of participants, and that they actually do measure jumping frequency.*

Key words: *newly-constructed tests, jumping frequency, factor validity, reliability, volleyball players.*

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Corresponding author: Darko Stojanović
University of Niš, Faculty of Sport and Physical Education, Čarnojevića 10a, Niš, Serbia
Phone: +381 18 510 900 • E-mail: darko89_nish@hotmail.com

INTRODUCTION

Speed, as a human motor skill, enables the performance of individual or complex sports activity movements in a short period of time, and is the main factor for achieving success in a series of sports (Željaskov, 2004). In many sports disciplines speed emerges as a complex ability which includes several inter-connected factors (Čoh, 2003), and makes up the "speed potential of an individual" in the related motor activity, with a certain exhibited dominance of one of them (Željaskov, 2004). In numerous studies, various forms were determined to exist, including motor reaction speed, single movement speed and frequency speed (Gredelj, Metikoš, Hošek, & Momirović, 1975; Hofman, 1980).

Frequency speed represents the ability to quickly perform several connected simple or complex movements and plays an important role in sports in which the ability to quickly repeat the same movements is pronounced, and which also includes quick movements within simple jumps (Booher, Hench, Worrell, & Stikeleather, 1993). Movement frequency speed primarily depends on the characteristics of the nervous system and the physiological characteristics of the activated muscles (Heimer & Matković, 1997).

Validity is the most important characteristic of measuring instruments used to measure motor skill, and if the relevant instrument is not valid, then the research results will not be valid either. External validity of the motor skill measuring instruments is determined using factor analysis, based on the previously defined sample of the measuring instrument as the research model, where there is either one or more measuring instruments for which factor validity is determined, as well as tests which have previously been determined to have factor validity. Factor validity is the relation which determines the level of realized results in the motor tests with acknowledged standards or criteria (for example, a properly defined motor factor), which were also measured simultaneously and during the same measuring procedure.

Reliability is a metric characteristic related to the accuracy of measurement, or the independence of unsystematized measurement errors, and is linked to the problem of result consistency in repeated measurements. In every measuring procedure on the results affect, except the size of the subject of measurement, and random variations in measurement results, which affect the measurement of unreliability, because the changes that they cause are not due to changes in the subject of measurement.

The basic aim of this study was to determine the external factor validity and reliability of seven newly-designed tests for the evaluation of jumping frequency in comparison to two tests whose validity and reliability have already been confirmed in previous studies, which will help determine the dimension being studied.

THE METHOD

Sample of participants

This research was carried out on a sample of 25 volleyball players aged 20.20±3.16 years (Mean±St.Dev.). The basic criterion of selection was that all of the participants had to be players on senior (varsity) teams which competed at national championships; all of the participants had at least six years of volleyball training and all of the participants were healthy during the study.

The sample of measuring instruments

1. Double leg quick lateral bounds (DLQLB, in s)
2. Double leg lateral bound (DLLB, in freq.)
3. Scissor jumps (SJ, in freq.)
4. Right leg jumps back and forth (RLJBF, in freq.)
5. Left leg jumps back and forth (LLJBF, in freq.)
6. Right leg side jump (RLSJ, in freq.)
7. Left leg side jump (LLSJ, in freq.)
8. Hand tapping (HTAP, in freq.)
9. Foot tapping (FTAP, in freq.)

In order to determine the factor validity, newly constructed tests were applied and two standardized tests (HTAP) and (FTAP) for assessing the frequency of simple movements, which are very common in use and have the best metric characteristics for the assessment of this dimension. They were taken from the battery of tests of Kurelić et al. (1975), and were applied to the population of young people aged 19-27 years, and were considered to be relevant for the selected sample of participants in this study. The measuring characteristics of the hand tapping and leg taping tests, which can be used to compare the newly-constructed tests, were confirmed in the studies of Momirović, Štalec, & Wolf (1975) and Gredelj et al. (1975), and their description was provided in Metikoš, Hofman, Prot, Pintar, & Oreb (1989).

Organization and description of the measuring

All tests were applied as composites with multiple repetition of the same motor tasks. Determination of the number of items in the tests was in accordance with the results of earlier studies, it has been proven that motor tests with more items change the quality of reliability in relation to tests with single items (Jovanović, 1994). Newly constructed tests for assessing the movement frequency (jumping), consisted of three items, according to the results of previous research, which showed that the tests for assessing the movement frequency HTAP and FTAP, which have the same structure as the newly constructed tests, give very reliable results (Munivrana, Čavala, & Viskić-Štalec, 2005), as well as some simpler tests of motor skills (jumping), whose metric characteristics evaluated in field trials (Marković, Dizdar, Jukić, & Cardinale, 2004; Stojanović, Stojanović, & Nešić, 2011; Sattler, Sekulić, Hadžić, Uljević, & Dervišević, 2012). Before testing subjects were preparing special warming, in which it applied stretching exercises, which initiates the mobility of the joints and dynamic exercises to increase muscle temperature.

1. Double leg quick lateral bounds (DLQLB)

Equipment: a stopwatch, 5 (five) hurdles made of foam in the shape of a cone 7cm high, 8cm wide at the base and 30 cm long. The hurdles were placed in parallel fashion in a row, at a distance of 60 cm each one behind the other.

Invigilator: there was one invigilator for each participant.

Overall duration of the test: until the participant jumps over all the hurdles in both directions.

The task: the participant stands with his right (left) hip facing the first hurdle. His arms hang freely at his sides. When the invigilator gives the sign NOW the participant does a double leg lateral bound and jumps over all 5 hurdles in a row, in one direction, and when he jumps over the final hurdle, he jumps over them in the opposite direction. The invigilator measures the time from the mark NOW until the participant makes a landing jump to the starting position after jumping over the final hurdle. He uses a free hand swing during the bound.

Rating: the measurements are in seconds, with a precision level of 1/10 seconds.

Guidelines: the test is performed three times, and the average result is taken.

2. Double leg lateral bound (DLLB)

Equipment: a stopwatch, one hurdle made of foam in the shape of a cone 7cm high, 8cm wide at the base and 30 cm long.

Invigilator: there was one invigilator for each participant.

Overall test duration: 20 s.

The task: the participant stands with his right (left) hip facing the first hurdle. His arms hang freely at his sides. When the invigilator gives the sign NOW the participant does a lateral bound and jumps over the hurdle and back again. He uses a free hand swing during the bound.

Rating: every lateral bound of the hurdle is taken into account.

Guidelines: the test is performed three times, and the average result is taken.

3. Scissor jumps (SJ)

Equipment: a stopwatch, one hurdle made of foam in the shape of a cone 7cm high, 8cm wide at the base and 30 cm long.

Invigilator: there was one invigilator for each participant.

Overall test duration: 20 s.

The task: the participant steps forward so that the hurdle is between his feet. His arms hang freely at his side when the invigilator gives the mark NOW the participant jumps upwards and changes the position of his feet above the line and makes a step landing, with his other leg forward. The movement is repeated this alternately.

He uses a free hand swing during the bound.

Rating: the overall number of scissor jumps is counted.

Guidelines: the test is performed three times, and the average result is taken.

4. and 5. Right leg jump back and forth (RLJBF) (the same test is also performed for the left leg - LLJBF)

Equipment: a stopwatch, one hurdle made of foam in the shape of a cone 7cm high, 8cm wide at the base and 30 cm long.

Invigilator: there was one invigilator for each participant.

Overall test duration: 20 s.

The task: the participant stands facing the hurdle on his right leg, with his leg left bent at the knee and lifted above the ground. His arms hang freely at his side. When the invigilator gives the sign NOW, the participant jumps over the hurdle with his right leg forward and jumps back straight away without touching the hurdle. He uses a free hand swing during the bound.

Rating: every jumps is counted.

Guidelines: the test is performed three times, and the average result is taken.

6. and 7. Right leg side jump (RLSJ) (the same test is also performed for the left leg - LLSJ)

Equipment: a stopwatch, one hurdle made of foam in the shape of a cone 7cm high, 8cm wide at the base and 30 cm long.

Invigilator: there was one invigilator for each participant.

Overall test duration: 20 s.

The task: the participant stands with the hurdle to his side, on his right leg, with his leg left bent at the knee and lifted above the ground. His arms hang freely at his side. When the invigilator gives the sign NOW, the participant jumps over the hurdle with his right leg to the side without touching the hurdle. He uses a free hand swing during the bound.

Rating: every jumps is counted.

Guidelines: the test is performed three times, and the average result is taken.

Statistical analysis

The measuring results were processed using the STATISTICA 7.0 statistic package (StatSoft, Inc., Tulsa, OK). For all items within the tests were calculated arithmetic mean (Mean) and standard deviation (Std.dev.), and for their condensation values, which are calculated as the arithmetic mean of the sum of the items of each test, are calculated arithmetic mean (Mean), standard deviation (Std.dev.) and coefficient of variation (Coef.Var). To calculate the homogeneity of items within the tests, was used analysis of variance for repeated measures (repeated measures ANOVA method). With reliability and item analysis method are calculated coefficients for determining the reliability (Crombach's alpha and Standardized alpha). To determine the factor validity of the newly constructed tests, after condensing the results in the items, the inter-correlation matrices of the tests were transformed into a structure matrix by using the method of principal components in the factor analysis. The number of significant principal components was determined using the Keiser-Guttmana criterion (Nunnaly & Bernstein, 1994), which extracts the principal components with values of 1.0 or greater. Factor validity represents one way of determining validity and is identified through significantly high correlations with the extracted factors (Nunnaly & Bernstein, 1994). The significance was determined at the $p \leq 0.05$ level.

RESULTS

The analysis of the descriptive parameters (Table 1) based on the variation coefficient indicates that the particles within the test are homogenous, but there was a trend of the smallest values occurring in the first item on all the tests, respectively, much higher values in the second and the third item. The differences in the item arithmetic means calculated by analysis of variance for repeated measures (repeated measures ANOVA method) were statistically significant, but based on post-hoc analysis of differences between pairs of items using Fisher LSD test, confirmed that the difference is significant only between the first and the other two items in all newly constructed tests. This systematic variation can be ignored, for reasons that were identified as motor learning, whose transfer is evident between the first and last two items, except in the test Double leg lateral bounds (DLLB), where the differences recorded between all three items and Hand tapping test (HTAP), where there were no statistically significant differences between items.

Results of calculation of reliability (Table 2) showed a high correlation between items in all measured tests, which can be seen from the values of Cronbach's and Standardized coefficient of correlation (0.81-0.93), and average values of the correlation between the items, which ranged from 0.59 to 0.82. Considering that the values of correlation coefficients of the items with the first principal component for all measuring instruments is very high (Factor loading = 0.83-0.97), and that the explanation of the total variance of all tests is very high (73% - 87%), and the variation of the results of correlation coefficients certain items around the mean value very little, it can be concluded that all newly constructed tests have satisfying reliability.

Table 1 The descriptive parameters of the items and condensed values of the tests

Test	Mean	Std.Dev.	Coef.Var.	p	Test	Mean	Std.Dev.	Coef.Var.	p
DLQLB (s)	3.87	0.33	8.55		DLLB (freq.)	48.71	5.02	10.31	
Item 1	4.14	0.37		*(1-2)	Item 1	46.24	5.64		
Item 2	3.87	0.45		*(1-3)	Item 2	49.36	6.23		*(1-2)
Item 3	3.61	0.34		*(2-3)	Item 3	50.52	5.03		*(1-3)
SJ (freq.)	58.55	5.96	10.18		RLJBF (freq.)	47.87	5.36	11.19	
Item 1	55.92	6.11			Item 1	44.56	5.81		
Item 2	59.36	6.24		*(1-2)	Item 2	49.20	5.40		*(1-2)
Item 3	60.36	6.84		*(1-3)	Item 3	49.84	6.62		*(1-3)
LLJBF (freq.)	47.39	4.57	9.65		RLSJ (freq.)	52.24	3.66	7.01	
Item 1	45.60	5.17			Item 1	50.44	4.71		
Item 2	48.28	4.50		*(1-2)	Item 2	52.84	3.76		*(1-2)
Item 3	48.28	5.02		*(1-3)	Item 3	53.44	4.18		*(1-3)
LLSJ (freq.)	51.19	4.82	9.41		HTAP (freq.)	52.51	6.66	12.69	
Item 1	49.84	5.53			Item 1	51.92	7.04		
Item 2	51.80	5.39		*(1-2)	Item 2	52.56	7.31		
Item 3	51.92	4.63		*(1-3)	Item 3	53.04	5.95		
FTAP (freq.)	37.04	3.11	8.40						
Item 1	36.48	2.86							
Item 2	37.00	3.64		*(1-3)					
Item 3	37.64	3.24							

Legend: Mean – arithmetic means; Std.Dev. – standard deviation; Coef.Var. – coefficient of variation; p –the significance of the difference between the items; *(1-2) – the significance of the difference between first and second item; *(2-3) – the significance of the difference between second and third item; *(1-3) – the significance of the difference between first and third item.

Table 2 Reliability of tests for the evaluation of jumping frequency

Test	Factor loading			Expl. Var.	% Total	Cronbach alpha	Standardized alpha	Average inter item corr.
	Item 1	Item 2	Item 3					
DLQLB	-0.85	-0.84	-0.87	2.18	73 %	0.81	0.81	0.59
DLLB	0.95	0.91	0.81	2.37	79 %	0.87	0.87	0.71
SJ	-0.89	-0.97	-0.94	2.60	87 %	0.92	0.92	0.82
RLJBF	-0.83	-0.93	-0.94	2.44	81 %	0.88	0.88	0.74
LLJBF	-0.93	-0.96	-0.91	2.62	87 %	0.92	0.93	0.82
RLSJ	-0.86	-0.89	-0.86	2.27	76 %	0.83	0.84	0.63
LLSJ	-0.90	-0.95	-0.94	2.60	87 %	0.92	0.92	0.80
HTAP	-0.98	-0.98	-0.98	2.91	97 %	0.98	0.98	0.95
FTAP	-0.97	-0.95	-0.96	2.76	92 %	0.95	0.96	0.88

Legend: Item – measurement unit, Factor loading – correlation coefficient between the item and the principal component, Expl.Var. – total explained variance, % Total – percentage of explained variance, Cronbach alpha – Cronbach's reliability coefficient, Standardized alpha – Standardized reliability coefficient, Average inter item corr. – average inter item correlation coefficient.

The moderate to high and statistically significant correlation coefficients (Table 3) between all the measured tests indicate that they, in addition to certain specific tests, have a similar measuring object. It was noted that the greatest correlation coefficient can be found between the DLQLB and DLLB (r=-0.74) and between HTAP and FTAP (r=0.82). However, the greatest relation can be found between the LLJBF and RLJBF (r=0.85). The smallest correlations with the other tests was determined for the DLLB test, and were all below the level of significance.

Table 3 Inter-correlation matrix

	DLQLB	DLLB	SJ	RLJBF	LLJBF	RLSJ	LLSJ	HTAP	FTAP
DLQLB	/								
DLLB	**-0.74**	/							
SJ	**-0.62**	0.34	/						
RLJBF	**-0.70**	0.36	**0.66**	/					
LLJBF	**-0.61**	0.37	**0.66**	**0.85**	/				
RLSJ	**-0.49**	0.30	**0.55**	**0.66**	**0.73**	/			
LLSJ	-0.28	0.30	0.33	**0.52**	**0.61**	**0.67**	/		
HTAP	**-0.47**	0.28	**0.65**	**0.59**	**0.64**	0.33	0.27	/	
FTAP	**-0.52**	0.27	**0.51**	**0.58**	**0.57**	0.39	0.29	**0.82**	/

Legend: Means – arithmetic means; Std.Dev. – standard deviation; DLQLB – double leg quick lateral bound; DLLB – lateral bound; SJ – scissor jumps; RLJBF – right leg jump back and forth; LLJBF – left leg jump back and forth; RLSJ – right leg side jump; LLSJ – left leg side jump; HTAP – hand tapping; FTAP – foot tapping.

By using a factor analysis (the method of principal components) (Table 3), we obtained three significant principal components, where the first main component explains almost 58% of the overall variance of all the tests, and the second and third 12.82% and 11.71%. The correlation coefficients of all the tests with the extracted components were valid, and varied in the range from -0.55 to -0.90, where the greatest projection on the first principal component was made by the Left leg jump back and forth test, and the smallest by the Double leg lateral bound. The Left leg side jump test had the greatest correlation with the second principal component, and the Double leg lateral bound with the third, but the

Table 4 The correlation coefficients of all the tests of jumping frequency with the extracted principal components, the overall explained variance and the percentage of the overall explained variance

Variables	Factor 1	Factor 2	Factor 3
DLQLB	**0.80**	-0.16	-0.50
DLLB	-0.55*	0.04	**0.77**
SJ	**-0.79**	0.16	-0.06
RLJB	**-0.89**	-0.08	-0.08
LLJBF	**-0.90****	-0.16	-0.15
RLSJ	**-0.76**	-0.49	-0.09
LLSJ	-0.61	**-0.63**	-0.14
HTAP	**-0.75**	0.49	-0.30
FTAP	**-0.73**	0.45	-0.26
Expl.Var	5.21	1.15	1.05
% Prp.Totl	57.86	12.82	11.71

Legend: Var. – the tests; Factor 1, 2 and 3 – the value of the correlation coefficient of the tests with the principal components; Expl.Var – the overall explained variance; % Prp.Totl – the percentage of the overall explained variance; ** - the highest value of the correlation; * - the lowest value of the correlation projections of the remaining 7 tests on these two components were very low. The correlation coefficients of all the tests with the first principal component are statistically significant at the p=.01 level, and have a high correlation, except for the Double leg lateral bounds and the Left leg side jump, whose correlation is mid high.

DISCUSSION

The factor analysis resulted in the extraction of the first principal component in which all 7 tests of jumping frequency and two tests of frequency of simple movements have high correlation coefficients (r=0.55-0.90; Table 2). Thus, it can be interpreted as the factor of frequency of simple movements. The second and third factor cannot sensibly be interpreted, considering that at least three tests do not have a correlation greater than 0.50 either with the second or third main component, so as to as meet the requirements of gaining factor status (Nunnaly & Bernstein, 1994).

The Left leg jump back and forth test (LLJBF) and the Right leg jump back and forth test (RLJBF) have indicated the highest relationship with the factor of simple movement frequency. Since the correlation between the tests and the extracted factor represents the factor validity of the test (Nunnaly & Bernstein, 1994), it is clear that these two tests have the best factor validity of all the analyzed tests. The Double leg quick lateral bounds and Scissor jumps (DLQLB and SJ) and the Right leg side jump, Hand tapping and Foot tapping (RLSJ, HTAP and FTAP) have a somewhat lower, but similar factor validity, while the Left leg side jump and Double leg Lateral bound (LLSJ and DLLB) have the lowest factor validity.

Reliability results of tests for the evaluation of jumping frequency, which show high reliability coefficients in the range 0.8-0.92, are compatible with the results of previous studies that have dealt with similar problems, which are proved good metric characteristics of tests. Reliability of more single leg frequency jumps tests has been proven in the range 0.77-0.99 (Booher et al., 1993); 0.92-0.97 (Ross, Langford, & Whelan, 2002); and 0.75-0.98 (Augustsson et al., 2006). Reliability of lateral step-up test on the 15 and 20 cm height podium for 15 seconds is detected in the range 0.90-0.94 (Ross, 1997), as well as the frontal step-up test on a 35 cm height bench for 15 seconds in the value of 0.89 (Munivrana et al., 2005).

We can conclude that among all the popular jumping tests, single leg jumps are the most reliable and proper tests for the evaluation of jumping frequency among physically active individuals. In the metric characteristics of tests of jumping frequency there is a problem regarding the inability of a comparison of the results from this study with previous ones, considering that there is a lack in the same or similar studies on this topic. In most of the aforementioned studies the testing procedure consisted of single leg jumps and the aim was limited to determining the reliability of these measuring instruments, and not their validity (Augustsson et al., 2006; Bolgla & Keskula, 1997; Paterno & Greenberger, 1996; Booher et al., 1993). The lack of information on the external factor validity of the studied tests limits their application for the purpose of determining measuring movement frequency, since factor validity is a relation which determines the level of the realized results on the motor test in comparison to the acknowledged standards or criteria, which were also measured simultaneously and as a part of the same measuring (Young, Macdonald, Heggen, & Fritzpatrik, 1997; Young, Macdonald, & Flowers, 2001). The limitations of the aforementioned studies also originates from the choice of the statistical method used to solve the problem of the metric characteristics of the tests, considering that the most frequently used methods for calculating within group differences between two measurings and their inter-correlations were mostly used in studies (Ross, 1997; Ross et al., 2002; Augustsson et al., 2006). A lack of parts on the tests of jumping frequency causes systematic errors, which often occur during the performance of several consecutive vertical and horizontal jumps. Namely, in some studies on the metric characteristics of tests of jumping ability and jumping frequency it has been indicated that better results were achieved during the final parts, which are the result of motor learning, and which the authors explain as coordination maneuvers and the motor complexity of the tests of consecutive jumps (Marković, Dizdar, Jukić, & Cardinale, 2004; Munivrana et al., 2005; Foretić, Uljević, & Prižmić, 2010; Stojanović et al., 2011). In such testing procedures, trials are proposed, so as to avoid any systematic variations between the test parts. Even in this research we can note better results in the last part on all the tests, but the differences between the parts are not statistically significant, and thus only the non-systematic variation of the results occurs.

For these reasons it is necessary when determining the metric characteristics, that the tests of jumping frequency be performed in at least three trials, with one test trial. It is also necessary to apply these tests in further studies on other samples, both on various age categories, as well as gender categories, but on a sample of other sports as well. It was only after two such results, and based on a detailed study, was it possible to make any general conclusions regarding metric characteristics, especially the factor validity and reliability for the evaluation of jumping frequency.

CONCLUSIONS

The metric characteristics of the measuring instruments are the basis of the application of these characteristics, as well as of their quality for the evaluation of any anthropological dimension. In this paper we studied the factor (external) validity and reliability of 7 newly-constructed tests for the evaluation of jumping frequency. The factor analysis was used to determine the factor validity of the tests that is the Frequency factor of simple movements was extracted, on which all of the tests were projected significantly.

Based on these results, we can conclude that the tests which were used to evaluate the frequency of the jumps possess factor validity and reliability and can be used to evaluate jumping frequency on the selected sample of participants. Finally, even though the factor analysis has shown that some tests have a high factor validity, we believe that it is necessary to confirm these results within other studies. In addition, we believe that it is also necessary to define the sample of participants more precisely, since the age range can significantly influence the research results.

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FAKTORSKA VALJANOST NOVOKONSTRUISANIH TESTOVA ZA PROCENU FREKVENCIJE SKAKANJA

Sa ciljem da se ispita faktorska valjanost novokonstruisanih testova za procenu frekvencije skakanja organizovano je eksperimentalno istraživanje na izorku od 25 odbojkaša starosti 20,20+3,16 godine. Za procenu frekvencije skakanja primenjeno je četiri testa jednonožnih skokova (skokovi levom i desnom nogom napred-nazad, skokovi levom i desnom nogom bočno) i tri testa obenožnih skokova (obenožni brzi skokovi bočno, obenožni skokovi u stranu i poskoci u iskoraku), kao i dva testa za procenu frekvencije pokreta, čija je faktorska valjanost već dokazana *(taping rukom i taping nogom). Rezultati ispitanika u ovim testovima su normalno distribuirani i imaju zadovoljavajuću osetljivost. Pomoću faktorske analize (metod glavnih komponenti) utvrđena je faktorska valjanost testova, sa koeficijentima od -0,55 do -0,90, gde najveću projekciju na prvu glavnu komponentu ima test skokovi levom nogom napred-nazad, a najmanju obenožni skokovi u stranu. Na osnovu rezultata može se konstatovati da svi testovi jednonožnih i obenožnih skokova imaju zadovoljavajuću faktorsku valjanost u prostoru frekvencije jednostavnih pokreta za ovaj uzorak ispitanika, te da stvarno mere frekvenciju skakanja.*

Ključne reči: *frekvencija skakanja, novokonstruisani testovi, faktorska valjanost, odbojkaši.*