ORIGINAL ARTICLE

TRENDS in
Sport Sciences
2017; **4**(24): 143-150
ISSN 2299-9590
DOI: 10.23829/TSS.2017.24.4-1

An evaluation of the reliability of the 8-second Skipping with Hand Clapping (8-s SHC) test with the use of the retest method

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Abstract

Aim of Study. The aim of this study was to evaluate the reliability of the 8-second Skipping with Hand Clapping (8-s SHC) test performed by young women and men. The presence of a "training trend" was checked during the evaluation. Material and Methods. The study involved 84 female students and 83 male students of the University of Warmia and Mazury in Olsztyn, aged 19-21 years (mean age: 19.44 ± 0.50 and 19.59 ± 0.49, respectively). The reliability of the 8-s SHC test was determined by calculating the values of correlation coefficients between the number of claps in 10 successive repetitions of the test. The "training trend" hypothesis was verified by the Friedman test and post-hoc tests. Results. The values of correlation coefficients between successive repetitions of the 8-s SHC test were within the range of acceptable reliability (0.80-0.90) to good reliability (0.90-0.94) in both genders. Statistically significant differences between the number of claps in successive repetitions of the 8-s SHC test point to the presence of a "training trend". Those differences were observed up to the fifth repetition in women and men. Conclusions. The 8-s SHC test is a reliable tool for assessing speed abilities among young women and men. The "training trend" should be eliminated before the test is used to evaluate speed abilities. A minimum number of 5 repetitions of the above motor test should be performed in advance for the final test to deliver reliable results. The study has shown that 8-s SHC Test is a reliable tool, which, after developing classification norms, can be used in the process of improving speed abilities for people of different ages.

KEYWORDS: reliability evaluation, retest method, training trend, speed abilities, 8-SHC test, university students.

Received: 15 September 2017
Accepted: 29 November 2017

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Introduction

Evaluations of physical fitness levels among university students based on adequate and reliable criteria are essential for validating the effectiveness of physical fitness tests implemented around the world [24]. University students have to engage in the appropriate kinesiology activities to develop and maintain their biotic motor abilities at satisfactory levels. The appropriate tools for assessing specific motor abilities are required to meet the above goal [8]. Satisfactory development of motor abilities lays the foundations for successful adoption and implementation of motor skills that are essential for daily activities and professional achievement in later life [4, 7]. Information about university students' motor abilities and skills, sources of motivation, strengths and needs should be gathered to ensure that the applied fitness tests are reliable [5]. The reliability of new measurement methods [26] as well as the most popular and generally acknowledged motor ability tests should be carefully revised [12].

New motor ability tests have to meet several adequacy criteria, including reliability. Low reliability of

measurements used to evaluate the level of speed abilities eliminates or at least significantly limits the usability of a given test as a measuring tool. If a given test, poorly correlates with itself, then it cannot be expected to show greater usability in assessing or anticipating another motor test. Low reliability coefficient prejudges that a given test will show poor correlation with any other one, regardless of what motor abilities it measures. Reliability is generally defined as consistency of measurements [3]. In the literature, the term 'reliability' is used synonymously with 'repeatability', 'reproducibility', consistency', 'agreement' and 'stability' [12]. The reliability of a test provides information about the magnitude of measurement error, and it is directly linked with the consistency of results obtained in repeated measures motor tests [11, 23]. A reliable test produces identical or highly similar results if it is conducted at least twice (retest method) in the same individuals and under the same conditions [15]. In most cases, reliability is determined by calculating the coefficient correlation between two repeated measurements [2, 13]. According to Osiński [13], the following estimated intervals of reliability (correlation) coefficients should be applied to evaluate motor abilities in motor tests: 0.95-0.99 – perfect reliability, 0.90-0.94 – good reliability, 0.80-0.90 – acceptable reliability, 0.70--079 – poor reliability, 0.60-0.69 – questionable reliability for individual assessments which is acceptable for group comparisons. A correlation coefficient of 0.70 is generally regarded as satisfactory in motor tests. The reliability of motor tests is also influenced by gender and age, and it is lowest in children and seniors, probably because these groups are characterized by mood swings and a short attention span [9, 10, 22]. Other limiting factors include physical and mental disabilities [25].

The presence of a "training trend", which points to a gradual improvement in motor abilities due to repeated performance of the same tasks, should also be identified during reliability assessments involving the retest method. A "training trend" can be diagnosed by analyzing correlation coefficients and the significance of differences between group means in successive repetitions [17]. The results of motor tests can be considerably influenced by the participants' health, mental condition, fatigue and motivation. The reliability of speed tests has been less frequently investigated in the literature, and the relevant assessments have been made in the Slalom test (speed) and the Hurdle test (agility) involving 11-year-old girls and boys [1] and the 4×10 m Shuttle Run test involving 13- and 14-year-old girls and boys [12].

The aim of this study was to evaluate the reliability of the 8-s Skipping with Hand Clapping (8-s SHC) test which was performed by female and male university students in 10 repetitions in weekly intervals. The above goal was pursued by answering the following questions:

1. What are the values of correlation coefficients between the results scored in each of the 10 repetitions of the 8-s SHC test?
2. Do the results (average number of claps) of successive repetitions reveal significant differences that could be indicative of a "training trend"?

Material and Methods

Participants

The study involved 84 female and 83 male first-year full-time students of the University of Warmia and Mazury in Olsztyn, aged 19-21 years (mean age: 19.44 ± ± 0.50 and 19.59 ± 0.49, respectively). The participants attended only obligatory physical education classes (90 minutes per week) and performed one 8-s SHC test per week. All participants were permanent residents of the Region of Warmia and Mazury in Poland.

Procedures

The study was carried out in compliance with provisions of the Declaration of Helsinki and upon the prior consent of the Bioethical Committee of the University of Warmia and Mazury in Olsztyn. All participants signed written consent forms.

Measurements

The results of the study could be significantly distorted by differences in the tested students' physical activity (PA) levels. For this reason, students who participated in extracurricular sports activities as well as students who were dismissed from physical education classes on medical grounds were excluded from the study. The International Physical Activity Questionnaire was used to evaluate the participants' PA levels before the study [14]. The students were asked to indicate the average weekly amount of exercise (minimum of 10 minutes) they had performed in the weeks preceding the study. The energy expenditure associated with the declared amount of weekly exercise was calculated and expressed in Metabolic Equivalent of Task (MET) units. The MET is the ratio of the rate of energy consumed during exercise to the rate of energy consumed at rest. One MET unit represents the amount of oxygen which is consumed in 1 minute, which is approximately equal to 3.5 mL/ /kg/min. The students were divided into groups with low (L < 600 METs-min/week), moderate (M < 1500 METs-min/week) and high (H ≥ 1500 METs-min/week)

PA levels based on the declared frequency, intensity and duration of exercise. Ultimately, only participants characterized by low PA levels, sedentary lifestyle and energy consumption of up to 600 METs per week were selected for the study. The results of the IPAQ survey were analyzed to reveal that none of the polled students had been sufficiently physically active. A homogeneous group of female and male respondents with equally sedentary lifestyles was selected based on IPAQ results which are not presented in this paper. Body mass and height were measured using a Martin anthropometer according to standardized guidelines. The results were used to calculate the Body Mass Index (BMI). Speed abilities were evaluated with the use of the 8-s Skipping with Hand Clapping (8-s SHC) test [19]. All participants repeated the 8-s SHC test 10 times in weekly intervals. Every student performed the test once in each week of the study.

Phases of the 8-s SHC test:

Phase I The participant starts the test in neutral position.

Phase II On the "start" cue, the participant runs in place for 8 seconds, lifting the knees high (thighs are at least perpendicular to the ground) and clapping hands under the bend knee.

Score: The score is the number of hand claps performed in 8 seconds.

Comments: During the test, the participant should not slouch, the torso should remain erect, hands should be clapped against each other under the knee, and not against a raised leg. The following errors disqualify the participant: torso excessively curled forward, slouching and clapping hands against a raised leg, leg not raised high enough.

Every female and male participant was given clear instructions on how to correctly perform the 8-s SHC test. The participants were able to improve their technique by practicing twice during each of the two meetings held before the study (2×2 repetitions). A five-minute warm-up routine was held before the test. The same routine was used in all groups. The following exercises and movement patterns were incorporated into the warm-up routine: jogging, wrist circles, elbow circles, arm circles, leg swings, jumps, balance exercises, front hold exercises, two 8-meter dashes, dynamic stretching and corrective drills [5]. The participants followed the same warm-up routine for 10 successive weeks in which measurements were performed.

Statistical analysis

The results were processed statistically to calculate minimum, mean and maximum values, median values, standard deviation and the coefficient of variation. Correlation coefficients were used to determine the presence of significant relationships between the independent variable (number of claps) and the dependent variable (successive repetition). The influence of successive repetitions (independent variables) of the 8-s SHC test, conducted in weekly intervals, on the average number of claps (dependent variable) in a given trial was analyzed to detect the presence of a "training trend". For this purpose, repeated measures ANOVA (parametric test) or the Friedman non-parametric test were performed for the dependent variable (number of claps). If significant differences were found, post-hoc tests were additionally used to identify the repetitions that differed significantly and could be indicative of a "training trend". All calculations were performed at a significance level of $\alpha = 0.05$ in the Statistica v.12 program [21].

Results

The analyzed anthropometric parameters of the study participants are presented in Table 1.

The mean BMI values were approximately 10% lower in women than in men, but they were within the norm in both groups. Standard deviation values point to smaller variations in body mass, height and BMI values in women than in men (Table 1).

The results (number of claps) scored by female and male students in each of the 10 repetitions of the 8-s SHC test are presented in Table 2.

The average number of claps in all repetitions was approximately 5% higher in the group of male students. Throughout the experiment, the values of standard deviation and the coefficient of variation were similar in both groups for the entire measurement series. A correlation analysis was performed to calculate the correlation coefficients between the number of claps in every repetition of the 8-s SHC test (Table 3).

Based on the previously described method for evaluating the reliability of motor tests [13], the calculated values of correlation coefficients between successive repetitions of the 8-s SHC test were indicative of acceptable reliability (0.80-0.90, minimum of 0.8226 in women and 0.7861 in men) to good reliability (0.90-0.94, maximum of 0.9277 in women and 0.9186 in men) in both groups (Table 3).

However, the calculated values of correlation coefficients did not support the determination of significant differences in the number of claps between successive repetitions of the 8-s SHC test. Additional analyses were carried out to determine the significance of differences

Table 1. Basic anthropometric characteristics of female and male students

Variable	Descriptive statistics					
	mean	median	minimum	maximum	SD	CV
Female students						
Age [years]	19.44	19.00	19.00	20.00	0.50	2.57
Height [cm]	168.11	168.40	158.20	179.50	5.09	3.03
Body mass [kg]	60.88	59.25	47.60	100.10	8.98	14.75
BMI [kg/m^2]	21.53	20.97	16.93	33.56	2.90	13.46
Male students						
Age [years]	19.59	20.00	19.00	20.00	0.49	2.53
Height [cm]	177.57	179.60	158.50	190.50	7.69	4.33
Body mass [kg]	75.36	75.10	50.60	110.20	14.54	19.29
BMI [kg/m^2]	23.76	23.00	17.47	32.56	3.54	14.89

Table 2. Average number of claps in successive repetitions of the 8-s SHC test

Variable	Descriptive statistics					
	mean	median	minimum	maximum	SD	CV
Female students						
I (number of claps)	24.61	24.50	20.00	30.00	2.10	8.53
II (number of claps)	24.74	25.00	20.00	29.00	2.16	8.72
III (number of claps)	25.08	25.00	21.00	29.00	2.01	8.03
IV (number of claps)	24.86	25.00	19.00	30.00	2.11	8.50
V (number of claps)	24.87	25.00	21.00	30.00	2.03	8.16
VI (number of claps)	24.88	25.00	20.00	29.00	2.01	8.07
VII (number of claps)	24.87	25.00	20.00	29.00	1.96	7.89
VIII (number of claps)	24.88	25.00	20.00	30.00	2.19	8.81
IX (number of claps)	24.88	25.00	20.00	29.00	2.10	8.45
X (number of claps)	24.88	25.00	20.00	30.00	2.04	8.22
Male students						
I (number of claps)	25.96	26.00	22.00	29.00	1.76	6.76
II (number of claps)	26.51	27.00	22.00	30.00	2.00	7.53
III (number of claps)	25.98	26.00	21.00	29.00	1.73	6.67
IV (number of claps)	26.18	26.00	21.00	31.00	1.99	7.62
V (number of claps)	26.00	26.00	21.00	29.00	1.85	7.11
VI (number of claps)	26.01	26.00	22.00	30.00	1.88	7.22
VII (number of claps)	26.07	26.00	22.00	30.00	1.85	7.08
VIII (number of claps)	26.00	26.00	21.00	30.00	1.83	7.03
IX (number of claps)	26.00	26.00	21.00	29.00	1.85	7.11
X (number of claps)	26.12	27.00	21.00	30.00	1.93	7.38

Table 3. Coefficients of correlation between selected dependent variables and successive repetitions of the 8-s SHC test in female and male students

Variable	Coefficients of correlation between successive repetitions are significant at p < 0.0500, N=84 and 83 (observations without valid data were eliminated)									
F M	I	II	III	IV	V	VI	VII	VIII	IX	X
I	1.0000	0.8839	0.8599	0.8537	0.8730	0.8457	0.8499	0.8560	0.8544	**0.8226**
II	0.8854	1.0000	0.9095	0.8934	0.9227	0.9243	0.9026	0.9157	0.9070	0.8699
III	0.8177	0.8220	1.0000	0.8698	0.8995	0.9202	0.8934	0.9141	0.9162	0.9100
IV	0.8374	0.8527	0.8414	1.0000	0.8785	0.9076	0.8646	0.9019	0.8807	0.8360
V	0.8042	0.8397	0.8650	0.8734	1.0000	0.8892	0.8946	0.9150	0.8862	0.8708
VI	0.7954	0.8184	0.8515	0.8917	0.8648	1.0000	0.8918	0.9190	0.9012	0.8916
VII	0.8282	0.8337	0.8510	0.8705	**0.9186**	0.8758	1.0000	0.8955	0.9045	0.8882
VIII	0.8396	0.8322	0.8475	0.8395	0.8195	0.8636	0.8563	1.0000	**0.9277**	0.8895
IX	0.8531	0.8397	0.8002	0.8403	0.8179	0.8472	0.8364	0.8412	1.0000	0.8967
X	0.9018	0.8617	**0.7861**	0.8124	0.7839	0.8217	0.8026	0.8582	0.8558	1.0000

Notes: minimum and maximum values are indicated in bold

Table 4. The results of Mauchly's sphericity test for female and male students

Effect	Mauchly's sphericity test, sigma-restricted parametrization, effective hypothesis decomposition			
	W statistic	x^2 statistic	*df*	*p*
Female students				
R1	0.450626	63.60709	44	0.028039
Male students				
R1	0.314733	91.09100	44	0.000039

Table 5. A comparison of the average number of claps in successive repetitions of the 8-s SHC test

Variable	Average rank	Rank sum	Sum	SD
Friedman ANOVA and Kendall's coefficient of concordance, chi-squared, ANOVA (Female, N = 84, df = 9) = 21.71194, p = 0.00984, coeff. of concordance = 0.02872, Aver. rank R = 0.01702				
I	4.773810	401.0000	24.60714	2.100016
II	4.952381	416.0000	24.73810	2.157191
III	6.428571	540.0000	25.08333	2.013259
IV	5.636905	473.5000	24.85714	2.112173
V	5.494048	461.5000	24.86905	2.028589
VI	5.482143	460.5000	24.88095	2.008445
VII	5.500000	462.0000	24.86905	1.962171
VIII	5.583333	469.0000	24.88095	2.192016
IX	5.523810	464.0000	24.88095	2.102235
X	5.625000	472.5000	24.88095	2.044120
Friedman ANOVA and Kendall's coefficient of concordance, chi-squared, ANOVA (Male, N = 83, df = 9) = 32.20390, p = 0.00018, coeff. of concordance = 0.04311, Aver. rank R = 0.03144				
I	5.120482	425.0000	25.96386	1.756144
II	6.885542	571.5000	26.50602	1.996176
III	5.138554	426.5000	25.97590	1.731881
IV	5.897590	489.5000	26.18072	1.994777
V	5.277108	438.0000	26.00000	1.847873
VI	5.319277	441.5000	26.01205	1.877297
VII	5.487952	455.5000	26.07229	1.846441
VIII	5.168675	429.0000	26.00000	1.827967
IX	5.144578	427.0000	26.00000	1.847873
X	5.560241	461.5000	26.12048	1.927956

between the average number of claps performed by students in successive repetitions of the test. The robustness of parametric and non-parametric statistics had to be verified before the relevant tests were used in calculations. For example, a parametric test of dependent

Table 6. The results of Duncan's post-hoc test indicating differences in the average number of claps in successive repetitions

Duncan's test; variable DV_1 (number of claps) Estimated probability values for post-hoc tests											
F	M	**24.607**	**24.738**	**25.083**	**24.857**	**24.869**	**24.881**	**24.869**	**24.881**	**24.881**	**24.881**
Trial		I	II	III	IV	V	VI	VII	VIII	IX	X
25.964	I	–	0.2216	**0.0000**	**0.0260**	**0.0235**	**0.0227**	**0.0270**	**0.0284**	**0.0267**	**0.0248**
26.506	II	**0.0000**	–	**0.0044**	0.2665	0.2516	0.2422	0.2710	0.2669	0.2604	0.2523
25.976	III	0.9171	**0.0000**	–	0.0720	0.0853	0.0930	0.0803	0.0589	0.0736	0.0845
26.181	IV	0.1176	**0.0050**	0.1362	–	0.9115	0.8430	0.9177	0.8533	0.8508	0.8476
26.000	V	0.7808	**0.0000**	0.8464	0.1778	–	0.9177	1.0000	0.9251	0.9235	0.9211
26.012	VI	0.7244	**0.0001**	0.7870	0.1876	0.9229	–	0.9115	1.0000	1.0000	1.0000
26.072	VII	0.4327	**0.0003**	0.4788	0.3812	0.5769	0.6028	–	0.9235	0.9211	0.9177
26.000	VIII	0.7713	**0.0001**	0.8351	0.1852	1.0000	0.9261	0.5881	–	1.0000	1.0000
26.000	IX	0.7870	**0.0000**	0.8529	0.1688	1.0000	0.9171	0.5604	1.0000	–	1.0000
26.120	X	0.2598	**0.0013**	0.2928	0.6028	0.3640	0.3812	0.6772	0.3744	0.3501	–

variables has to be evaluated for sphericity. The results obtained for both groups are presented in Table 4.

The results of preliminary calculations (Mauchly's sphericity test) revealed that the differences between the results scored in each repetition of the 8-s SHC test did not meet the assumption of sphericity (because $p < 0.05$) in either group. Therefore, the Friedman non-parametric test, an alternative to repeated measures ANOVA for dependent variables, was applied to verify the research hypotheses. The average number of claps in successive repetitions of the 8-s SHC test is presented in Table 5.

The Friedman test revealed significant differences between the average number of claps in successive repetitions of the 8-s SHC test ($p < 0.05$) in both groups. In the next step, Duncan's post-hoc test was applied to determine which repetitions differed significantly in the average number of claps. The results are presented in Table 6.

In both groups of respondents, significant differences in the average number of claps were observed until the second repetition of the 8-s SHC test (Table 6).

Discussion

The present study, conducted in line with the adopted procedural algorithm, produced interesting results. Significant differences in the average number of claps between successive repetitions of the 8-s SHC test, which could be indicative of a "training trend", were observed in both female and male students up to the fifth repetition (2 × 2 repetitions of the test performed in the weeks preceding study and the one repetition between trials I and II).

A "training trend" was also observed during a 500 m rowing test performed by female and male university students on an ergometer. Female participants steadily improved their results up to the fourth repetition, and male subjects – up to the fifth repetition of the test [16, 17]. In the 3-minute Burpee test, the training trend disappeared after the fifth repetition [20].

The duration of exercise significantly influences the reliability of a test. In tests that last relatively long, such as endurance runs, measurement error is compensated by other factors (for example cardiovascular endurance), which increases reliability. In contrast, most speed and coordination tests are short, therefore, error compensation does not take place [13]. In order to assess if a motor test is reliable, parallel-test method can be applied, which is about estimating one motor ability by means of different tests that are next tried for correlation. A group of kindergarten children was subjected to such a test, in which the 8-s SHC test corresponded with other motor tests, for instance, 4 x 10 m shuttle run to test speed (+0.73), standing long jump to test dynamic strength of lower limbs (+0.58), and sit-ups for 30 seconds to test abdominal strength (+0.62) [18]. The above suggests that the evaluated test has a more hybrid character.

Practical Implications and Limitations

The results of this study indicate that the 8-s SHC test is suitable for population studies and can be carried out with relative ease and at low cost even under difficult conditions. A comparison of the values of correlation

coefficients in successive repetitions of the test indicates that the reliability of the 8-s SHC test ranges from acceptable to good. In physical fitness tests, the minimum required value of the correlation coefficient is 0.70, therefore, the 8-s SHC test can be effectively used to assess speed abilities in young women and men. To date, reliability assessments have been carried out mainly in cardiorespiratory fitness, muscular endurance and flexibility test [12]. Therefore, further research is needed to determine the reliability of the 8-s SHC test in different age groups and to develop classification standards for those age groups based on representative samples of the studied population groups. Developing classification norms for different age groups would allow better usage of the 8-s SHC Test in the studies related to the changes in man's speed abilities. The controlling of the speed abilities level based on a higher number of motor tests would be more extensive and accurate.

Conclusions

1. The 8-s SHC test can be reliably used in female and male university students aged 19-21. The values of correlation coefficients between successive repetitions of the test were indicative of acceptable to good reliability in both female and male students.
2. Statistical analyses revealed significant differences in the number of claps between successive repetitions of the 8-s SHC test (up to the fifth repetition). The "training trend" has to be eliminated to guarantee that the 8-s SHC test reliably evaluates the speed abilities of young females and males. A minimum of 5 repetitions should be performed before the test can be reliably used to assess the speed abilities of university students.

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