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Validity and reliability of non-apparatus and quasi apparatus flexibility tests – verification during health-related training based on judo

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Abstract

Background & Study Aim: Insufficient body's motor preparation not only for specific physical effort during judo training, but in general is one of a significant factor contributing to risk of body injuries. Normal range of motion in each joint and appropriate state of body stimulation before physical effort is decreasing the risk of body injuries. It refers especially to a practice fighting and other shot-lasting extreme efforts. The purpose of this study is recommendation of this or those from non-apparatus and quasi apparatus flexibility tests, which fulfills the highest standards of validation procedure relativized by changing state of body stimulation during training, therefore also flexibility level of muscles and joints.

Materials & Methods: Eight male subjects who are attending to judo recreation training sessions (as a form of health-related training) were examined. Their age ranged from 18 to 43 years (mean 28.8 ±8.5) and their training experience ranged from 0.5 to 3 years (mean 1.4 year). In assessment, three flexibility tests were used each time in three different training situations, switching the order of their usage: *forward bending test – finger-floor distance (FFD); modified measurement of finger-floor distance – self-assessment Bending scale (SABS); self-assessment sit reach test (SASRT).* None of applied test was favored, because order of its application was switched each time. Intensity zones of exercised was determined using criteria determined by Pollock et al.

Results: There is no link between state of body stimulation during judo recreation training and change of flexibility level of tested subjects. SASRT and FFD test fulfilled the criteria of validity and reliability as an assessment tool for measuring flexibility level in different states of body stimulation and different training situations. SABS test did not fulfill enough criteria of validity and reliability, so it has not been acknowledged as a worthy tool for health-related training.

Conclusion: In terms of application in sport training and behavioral therapy, SASRT deserves the highest recommendation. It fulfills the criteria of validity and reliability of assessment in a different states of body stimulation. At the same time, it is the simplest and the safest in application from flexibility tests.

Key words: extreme effort · heart rate · intensity zones · motor safety · validation procedure

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Motor safety – is consciousness of the person undertaking to solve a motor task or consciousness the subject who has the right to encourage and even enforce from this person that would perform the motor activity, who is able to do it without the risk of the loss of life, injuries or other adverse health effects [17].

Effort safety – is consciousness of the person who starts physical effort or consciousness of the subject who has the right to encourage or even enforce from this person the physical effort of a certain intensity and duration, who it is able to do so without risking life or health [17].

Tatami – traditional straw mats used in judo and aikido training halls.

INTRODUCTION

Insufficient body's motor preparation not only for special physical effort during judo training is one of the crucial injury risk factors. Normal range of motion in joints and appropriate state of body stimulation before physical effort is decreasing this risk, especially during training fights and other extreme physical efforts [1]. High level of flexibility in reference to general population is not only decreasing risk of injury during a training, but also in situation of uncontrolled fall, while in short period of time the body is suddenly mobilized to take great effort in order to protect the vital parts of body from injury [2].

One of the components of muscle strength and possible speed is entry level of muscle flexibility [3]. Static and dynamic flexibility has an influence on muscle balance, potential maximal strength and smoothness of movement [4]. Most of throwing techniques in judo and during a fight in horizontal posture (*ne waza*) requires sufficient range of motion of a spine and lower limbs. That is why high level of flexibility allows to perform better in sport fights and also is decreasing a risk of injury [5].

Proper range of motion in joints allows to smooth and proper execution of techniques in combat sports. It also allows body to set up in a way that will minimize effects of fall or collision [6]. Sudden acceleration during performing motor task may contribute to damaging hamstrings muscles, that is why maintain high level of flexibility allows to reduce a risk of injuries in lower limbs [7].

Treating martial arts and combat sports especially as recreational activity, without an aspiration to have good results in competitions, it is important to monitor and be self-conscious about one's own condition. Proper approach to training, valid and reliable assessment of one's own condition will allow to select proper training workload. It will allow to minimize the risk of potential injury and give it characteristic of health-relation training [8].

To monitor state of the body and to assets motor abilities during therapy or training, we use tests with and without special tools. Those tests that do not require any tools are called non-apparatus tests. Those test that requires simple measuring tools or training accessories (ruler, training bag or medicine ball) recognized as pseudo-tools are called quasi-apparatus tests [9]. Non-apparatus and quasi-apparatus flexibility tests are easy to use and can be used without any tools or with a usage of simple scale like in case of finger-floor distance test [10].

The purpose of this study is recommendation of this or those from non-apparatus and quasi apparatus flexibility tests, which fulfills the highest standards of validation procedure relativized by changing state of body stimulation during training, therefore also flexibility level of muscles and joints.

MATERIAL AND METHODS

Participants

Eight male subjects who are attending to judo recreation training sessions (as a form of health-related training) in Student's Sport Section in Academy of Physical Education in Katowice in Poland were examined. Their age ranged from 18 to 43 years (mean 28.8 ±8.5) and their training experience ranged from 0.5 to 3 years (mean 1.4 year).

The study was conducted within the research project Academy of Physical Education in Katowice: "Reducing vulnerability to body injuries during the fall of people categorized as group being at high risk of losing balance and falling" (Resolution No. 04/2013 Bioethics Committee at the Jerzy Kukuczka Academy of Physical Education, Katowice, Poland).

Methods and protocols

Assessment of flexibility – three test measuring flexibility of spine and hamstrings muscles

In assessment, three flexibility tests were used each time in three different training situations, switching the order of their usage: *forward bending test – finger-floor distance (FFD)* [10]*; modified measurement of finger-floor distance – self-assessment bending scale (SABS)* [11]*; self-assessment sit reach test (SASRT)* [9]. None of applied test was favored, because order of its application was switched each time.

Finger-floor distance (FFD) was applied as first (a) by a method of drawing. Modified measurement of finger-floor distance (SABS) was applied as second (b), and self-assessment sit reach test (SASRT) was applied as third (c). Order of respective assessments in each training was switched according to "a-b-c" order in situation A (before exercises), "b-c-a" in situation B (after 30 minutes of exercises) and "c-a-b" in situation C (immediately after end of exercises). On the next training session, first test was switched, but rotation order method remained the same.

Instruction of assessment method of finger-floor distance test (FFD)

Flexibility assessment in this test is made in sagittal plane, and its criteria is distance between tips of fingers of both hands (which are placed one next to another) from surface, where tested person stands. In the assessment, knee joints need to be straighten, and medial malleolus needs to be stacked together. Assessing of the distance between tips of third fingers to support plane is made by using a ruler with accuracy to 0.5 centimeter. In a case, where tested person did not reach a line of support plane, given result is marked with "– "sign. Results, like in cases of other tests, were documented on special chart [10].

Instruction of assessment method of modified measurement of finger-floor distance – self-assessment bending scale (SABS)

Tested person stands with foot connected to each other and starts to slowly bend forward, while keeping knees at full extension. Distance where measured to the point, where tip of third fingers reach lowest. Results are interpreted using seven-point scale: (1) tips of fingers cannot reach knee joints; (2) tips of fingers can reach knee joints, but wrists cannot; (3) wrists can reach below knee joints, but tips of fingers cannot reach below ankles; (4) tips of fingers can reach ankles, but cannot reach the floor; (5) fingers can reach the floor; (6) all fingers can reach the floor; (7) whole hand can be placed on the floor. Before the test, tested person was instructed about those criteria. After test they were self-assessing results and passing them to observer [11].

Instruction of assessment method of self-assessment sit reach test (SASRT)

In a sitting posture, legs should be fully extended and set apart in a distance of one foot. Heels should be placed on one line, that was determined before test (in a judo training session, it was a line of connection of tatami). One hand is put between knees with fingers pointing forward. Other hand is placed on a first hand, but turned by 90 degrees. Knees should remain extended while hands are sliding on a surface towards heels to the point of toleration of discomfort for about 2 seconds. Without changing a position on hands, tested person bend knees and starts to assess the results.

If tip of third finger were placed on marked line, then raw result was "0". If line of styloid process of the ulna and radius bones were reaching beyond marked line, then result was "1+". If a result was between "0" and "1+", was determined for "0.1+". This value was determined by distance between second and fourth finger of tested person. So results above "1+" higher by this distance was scored as "1.3+", and a value below "1+", lower by this distance was scored as "0.7+". It the same way, in situation where gained result was lower than "0", and it was lower by distance of second finger, it will be scored as "0.1− " [9].

Criteria of validation of flexibility tests

Initial assumption says, that quasi-apparatus finger-floor distance test (FFD) is a valid assessment tool in different states of body stimulation in judo training.

As a criterion of construct validity of non-apparatus tests, correlation coefficient between finger-floor distance test and non-apparatus tests was taken. For criterion of internal validity of applied tests, coefficient of variances of test used three times was taken.

As a criterion of reliability correlation coefficient between test results used three times was taken. As additional criterion of reliability I take correlation between differences of raw results of flexibility tests and value of HR of trained persons in different training situations. The point is to conclude, whether differences in a state of body stimulation have connection with changes of flexibility level of trained persons.

Assessment of intensity of physical effort

Assessment was based on intensity zones of physical effort (exercises) for adults designed by Pollock et al. [12]. (%HRmax), where intensity is: <35% very light (I_{VL}); 35-54% light (I_{L}); 55-69% moderate (I_{MO}); 70-89% hard (I_{H}); 90-99% very hard (I_{VH}) and 100% maximal (I_{M}). Kalina [13] added zone supramaximal >100% (I_{SM}).

Tested persons assess HR using palpation method on carotid artery. On command "start" they begin, and they stop for command. Resting HR was measured directly before exercises in a period of 60 seconds. In a break in physical effort, HR was measured in 6 seconds (on "start" command, they count from "0"). This method is recommended because of simplicity of multiplying result by 10 to obtain a minute HR [13]. HR was measured once in 15 minutes, so established training intensity zones for situation B and C are mean results of two measurements.

This result (intensity zone in situation B and C) as well as resting HR (situation A) is at the same time simplified measurement of body stimulation.

Statistical analysis

Collected data was computed using common statistical methods. Sum, mean, standard deviation, kurtosis (g1) and skewness (g2) was computed. Correlation between variables was assessed using Pearson's correlation coefficient, coefficient of variances and coefficient of determination.

RESULTS

1. Body workload of physical effort during training session

HR results of three following one after another situation, measured on each training are similar. Although nominal changes, intensity of all exercises (high intensity zone) in individual situations means that despite differences in a scope of exercise and its content on each training, tested judokas have showed similar level of body stimulation for each assessment situations (Table 1).

2. Correlation between level of flexibility and a state of body stimulation of tested judokas

There were none significant correlations between change of level of flexibility in situations A, B and C as well as between their reviled intensity of training. Changes in correlation coefficient level in each training and its low values indicates lack of clear correlation between state of body stimulation and changes of flexibility level during training (Table 2).

None of significant correlation were showed between level of flexibility and changes of HR values of tested judokas for each training situation. Big dispersity between correlations for each tests in different training sessions in different situations do not allow to establish any link between changes of heart rate values between different measuring situations and changes of flexibility level for any of applied tests (Table 3).

3. Content validity of flexibility tests

In flexibility assessment in resting state on each training session, results of SABS showed higher correlation values with results of FFD than SASRT (Table 4).

In measuring situation B and C, for 4 of 6 assessment pairs SASRT showed higher correlation values with FFD test. In situation A, mean value of correlation between FFD and SABS as well as between FFD and SASRT was $\bar{x}r = 0.877$.

In situation B, mean correlation values of results between FFD and SABS was $\bar{x}r = 0.811$ and $\bar{x}r = 0.765$ between FFD and SASRT.

Table 1. Average (X) values of heart rate (resting HR in situation A) and intensity of exercises (%HRmax) for situations B and C during different trainings (T) of tested persons (n = 8).

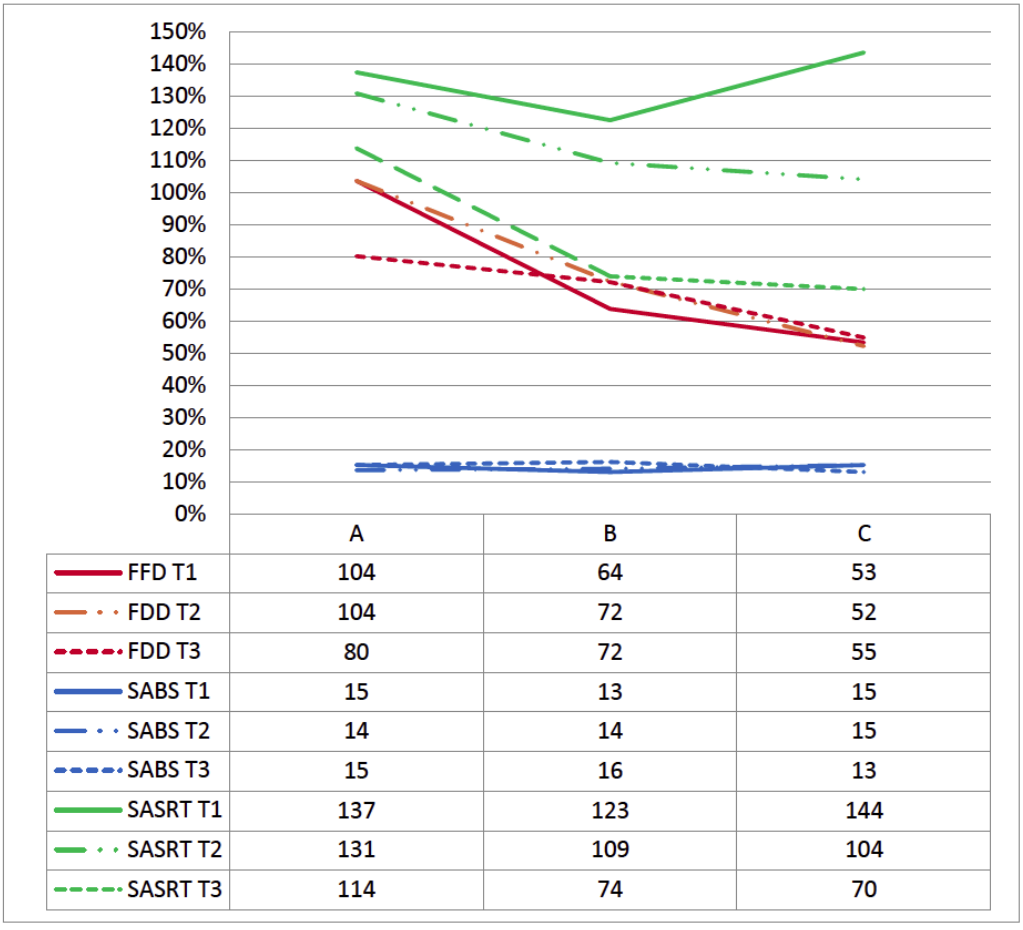
	Heart rate (beats per minute)				Intensity of exercises (%HRmax)	
T	X	SD	min	max	X	zone
			Situation A			
T1	**78.13**	7.43	67	88		
T2	**78.75**	4.40	73	85		
T3	**76.88**	7.64	66	92		
			Situation B			
T1	**147**	12.25	125	162	**78**	hard (I_H)
T2	**148**	10.46	129	162	**79**	hard (I_H)
T3	**140**	4.83	132	146	**74**	hard (I_H)
			Situation C			
T1	**167**	9.67	145	175	**89**	hard (I_H)
T2	**147**	9.37	134	160	**79**	hard (I_H)
T3	**145**	13.11	132	168	**77**	hard (I_H)

Table 2. Correlations between changes of flexibility level (measured by various tests) and state of body stimulation (based on exercise intensity measured %HRmax) of tested judokas (n = 8) in different training situations B and C.

Test	Situation B			Test	Situation C		
	T1	T2	T3		T1	T2	T3
FFD	0.239	0.492	0.057	FFD	–0.156	–0.665	–0.559
SABS	0.181	0.159	0.039	SABS	0.136	0.119	0.000
SASRT	–0.464	–0.448	0.391	SASRT	–0.479	–0.291	–0.065

Table 3. Correlation between changes of flexibility level and changes of HR value of tested judokas in different training situations.

Test	A-B			Test	A-C			Test	B-C		
	T1	T2	T3		T1	T2	T3		T1	T2	T3
FFD	–0.217	0.462	0.548	FFD	0.088	–0.231	–0.313	FFD	–0.006	–0.487	–0.159
SABS	0.489	0.512	0.664	SABS	0.046	–0.269	0.337	SABS	0.488	–0.127	0.266
SASRT	–0.385	–0.128	0.478	SASRT	-0.259	–0.156	0.311	SASRT	–0.338	–0.071	0.068



	A	B	C
FFD T1	104	64	53
FDD T2	104	72	52
FDD T3	80	72	55
SABS T1	15	13	15
SABS T2	14	14	15
SABS T3	15	16	13
SASRT T1	137	123	144
SASRT T2	131	109	104
SASRT T3	114	74	70

Figure 1. Values of coefficient of variances (in %) of applied tests in different judo training situations (A, B, C).

Table 4. Summary of mean values of flexibility tests results and correlation between tests in different training (T) situations (SIT) – significant correlation p<0.05 are bolded

T	SIT	Test	Coefficient r		Statistical variables					
			1.	2.	Results	±	x̄min	x̄max	g1	g2
		1. FFD	–		5.81	6.03	–2	16	–0.31	0.71
	A	**2. SABS**	**0.819**	–	5.75	0.89	5	7	–1.48	0.62
		3. SASRT	**0.806**	**0.558**	0.36	0.50	–0.3	1	–1.39	0.07
		1. FFD	–		7.88	5.03	1	15.5	–0.81	0.31
T1	B	**2. SABS**	**0.596**	–	5.63	0.74	5	7	–0.15	0.82
		3. SASRT	0.778	**0.377**	0.34	0.41	–0.1	1	–1.29	0.63
		1. FFD	–		8.56	4.58	4	16	–1.10	0.34
	C	**2. SABS**	0.867	–	5.75	0.89	5	7	–1.48	0.62
		3. SASRT	0.800	**0.598**	0.30	0.43	–0.3	0.8	–1.87	–0.30
		1. FFD	–		5.50	5.71	–1	15	–0.75	0.67
	A	**2. SABS**	0.927	–	5.50	0.76	5	7	0.88	1.32
		3. SASRT	0.899	0.776	0.36	0.47	–0.4	1	–0.87	–0.15
		1. FFD	–		8.25	5.98	3	16.5	–1.21	0.63
T2	B	**2. SABS**	0.824	–	5.88	0.83	5	7	–1.39	0.28
		3. SASRT	0.945	0.900	0.40	0.44	–0.1	1	–1.8	0
		1. FFD	–		8.38	4.38	3	13.5	–1.63	–0.05
	C	**2. SABS**	**0.395**	–	5.75	0.89	5	7	–1.48	0.62
		3. SASRT	0.787	**0.437**	0.36	0.38	–0.1	1	–0.34	0.35
		1. FFD	–		6.63	5.32	2	16	–0.16	1.12
	A	**2. SABS**	0.886	–	5.75	0.89	5	7	–1.48	0.62
		3. SASRT	0.717	**0.692**	0.45	0.51	–0.2	1	–2.10	0.00
		1. FFD	–		7,00	5.06	3	15	–0.45	1.00
T3	B	**2. SABS**	0.910	–	5.63	0.92	5	7	–1.04	1.00
		3. SASRT	**0.618**	**0.426**	0.51	0.38	–0.1	1	–0.96	–0.25
		1. FFD	–		8.25	4.54	3.5	17	0.78	1.03
	C	**2. SABS**	0.730	–	5.63	0.74	5	7	–0.15	0.82
		3. SASRT	0.801	**0.573**	0.55	0.39	0	1	–1.67	–0.01

In situation C, mean value of correlation of results of SASRT was higher with value of r = 0.796. Value of correlation for SABS test was moderate with result of r = 0.664. Mean value of all correlations between results of FFD and SABS test was x̄r = 0.773 and x̄r = 0.794 for result between FFD and SASRT.

Therefore, SASRT indicates slightly stronger correlation with FFD test results. Although comparable mean values of correlations, because of one moderate correlation in situation C was showed, there are no theoretical bases to qualify SABS as valid test.

4. Internal validity of flexibility tests

Results of SABS showed the lowest values of coefficient of variances for every situation, maintaining level of 13-16%. FFD test in situation A showed values ranged from 80% to 104%, but in situation B

Table 5. Results of correlation coefficient of flexibility tests applied thrice in different situations (SIT); A before training; B after 30 minutes of exercises; C directly after the end of training session (significant correlation for p<0.05 is bolded).

SIT	Test	Training			x̄r
		1-2	1-3	2-3	
A	FFD	0.927	0.884	0.952	0.921
	SABS	0.853	0.818	0.853	0.841
	SASRT	0.947	0.909	0.924	0.926
B	FFD	0.964	0.906	0.905	0.925
	SABS	0.834	**0.603**	**0.677**	0.705
	SASRT	0.923	0.860	0.920	0.901
C	FFD	0.925	0.715	0.767	0.802
	SABS	**0.636**	0.921	**0.487**	0.681
	SASRT	0.913	0.783	**0.672**	0.789

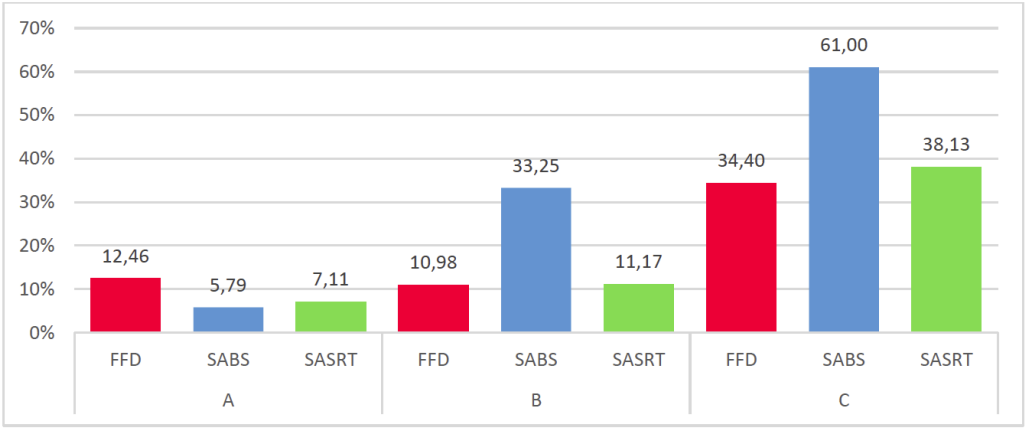


Figure 2. Visualization of results from table 6: differences between extreme values of coefficient of determination (in %) in following applications of test (situation A before training; B after 30 minutes of exercises; C directly after the end of training session).

and C those values were decreasing, maintain a range from 64-72% to 52-55% respectively. Highest values of coefficient of variances were showed for results of SASRT, obtaining results of 104-107% in situation A, 109-123% in situation B, to 70-144% in situation C. Therefore, SASRT shows highest sensitivity among all applied tests (Figure 1).

5. Reliability of flexibility tests

In situation A, results of FFD test and SASRT showed very high correlations (x̄r = 0.921 and x̄r = 0.926) and test SABS high correlation (= 0.841).

In situation B, results of FFD test and SASRT also showed very high correlations (x̄r = 0.925 and0,901 respectively). SABS results lowered to a value of x̄r = 0.705.

In situation C, tests FFD and SASRT showed high correlation values (x̄r = 0.802 and x̄r = 0.789 respectively).

Test SABS showed moderate correlation between results in situation C (x̄r = 0.681). For all three situations, mean value of correlation between applied tests was x̄r = 0.883 for FFD, x̄r = 0.872 for SASRT and x̄r = 0.742 for SABS (Table 5).

In a situation A all three tests were characterized by low difference between extreme values of coefficient

of determination. Lowest value was showed by SABS test and the highest by FFD test. In situation B, SASRT and FFD shows similar value of coefficient of determination on a level of 11%, while SABS test results increase this value by six time to 33.2%. In situation C, tests SASRT and FFD obtained higher values (38.13% and 34.40% respectively). Test SABS increased this value by doubling it to level of 61% (Figure 2).

Coefficient of determination between compared pairs of test in situation A were characterized not only by low dispersity, but also as high values of R^2 (in %). In situation B, SASRT and FFD tests were characterized by high values of coefficient (about 80%). SABS test showed lower values (between 36.30% to 69.56%). In situation C, every test at least once was characterized by lower in situation A and B averaged value of coefficient R^2. Lowest documented value of FFD test was 51.07% and the highest was 85.47%, whereas SABS test lowest was 23.75% and the highest was 84.75%. SASRT showed lowest values of 45.17% and he highest at 83.30% (Table 6).

DISCUSSION

All three training sessions, where flexibility level measurements were collected had a nature of preparation to fight in horizontal posture, including kneeling and supporting on forearms (*ne waza*). Repeatable nature of training and relatively homogenous state of body stimulation during measurements was crucial for reliability of conducted assessments. Before training, tested judokas were not stimulated, and what values of resting HR justified (60-80 beats per minute) and is normal value for healthy and trained persons. Training sessions was conducted in an evening around 7 or 8 p.m. Although during all day tested sportsmen could undertake different type of physical activity or physical work, time required to arrival to a training place and changing clothes was sufficient to make assumption, that before training sessions, their bodies were not stimulated beyond the point of normal daily activity.

Results of intensity of physical effort indicates, that tested judokas were stimulated on a high level after 30 minutes of exercises as well as directly after the end of exercises. Presented differences in-between persons (in %) HR maximal values in separate situations were meaningful variable for further interpretation of validity and reliability. In this interpretation, HR (as an indicator of body stimulation) values are substantial in the middle and at the end of training. Relatively homogenous resting HR state allows to conclude that judokas in physiological meaning were in similar condition before training. Content of training session, individual commitment, level of adaptation to physical effort etc. are factors which determine state of body stimulation of every participant. Therefore, diversity of results of applied tests are in some way confirmation of their sensitivity for changing motor capabilities of a man under influence of body stimulation.

Results of correlations between changes of flexibility level and changes of state of body stimulation showed,

Table 6. Values of coefficient of determination (in %) for three measurement pairs for each flexibility test for three training situations (SIT).

SIT	Test	Training			$\bar{x}R^2$
		1-2	1-3	2-3	
A	**FFD**	85.90	78.20	90.66	**84.84**
	SABS	72.73	66.94	72.73	**70.77**
	SASRT	89.65	82.54	85.39	**85.84**
B	**FFD**	92.93	82.15	81.95	**85.60**
	SABS	69.56	36.31	45.88	**49.65**
	SASRT	85.22	74.05	84.70	**81.24**
C	**FFD**	85.47	51.07	58.89	**64.35**
	SABS	40.50	84.75	23.75	**46.44**
	SASRT	83.30	61.25	45.17	**62.28**

that there is none clear correlation between those variables. Therefore, it seems to be true statement, that during judo training where there were no specific exercises designed to improve flexibility, sole state of body stimulation did not affect level of flexibility.

The most precise is assessment using quasi-apparatus finger-floor distance (FFD) test, where ruler is required. That is why scores are put with accuracy to 0.5 centimeter. Modified finger-floor distance test (SABS) is characterized by very wide scale based on anatomical marks on body. Given points is determined by how far specific points are placed in front of torso or how much fingers are placed on surface. Depending of morphological characteristic of assessed person, one point could divers for couple to several centimeters.

During assessment using second non-apparatus flexibility test (SASRT), tested person is using a width of their second to fourth fingers to obtain raw results (basic measuring unit is a width of one finger). This unit is similar to a way of determining points in acupuncture in Chinese medicine, where distance between acupuncture points is determined by a "cun" unit, which stands for width of II-IV fingers [14].

Based on studied literature [10] I assume, that finger-floor distance is valid assessment tool. Previous studies were conducted in condition of resting state of the body. Maintained very high correlation of results in a middle of training and very high directly after the end of exercises indicates, that this assessment tool is also valid in a stimulated body state.

Results of non-apparatus tests are highly correlated with FFD test before training. So it seems to be true statement, that they are valid in a situation where body is in a resting state. Although in a state of body stimulation, results of SABS are decreasing a level of correlation with assumed frame of reference (FFD test), while state of body stimulation is increasing. In contrast, results of SASRT are correlating higher in every comparison with quasi-apparatus test (FFD).

In the same time, determining internal validity, I computed results of coefficient of variances of applied tests. The highest sensitivity was showed in SASRT, while SABS showed the lowest. That is why I assume, that despite high correlation with FFD test, SABS did not fulfill enough criteria to be recognized as a valid assessment tool. Lack of required precision of this test is depending on giving exact the same score for person who reach directly below kneecap or slightly above ankle. In addition, results of finger-floor distance tests results could be easily distorted by compensating with slight knee flexion, which cannot be always noticed by observer. Applied test should serve as a tools for self-assessment of training persons. That is why possibility of such compensation for sole reason of comfort of perception of making progress could be attractive and hard to eliminate alone. If tested person is assessed by external observer, and knees are exposed it is much easier to determine, whether knees are pressed to a surface during measurements.

Very high correlation between separate flexibility measurements (homogenous pairs) indicates reliability of applied flexibility tests on general level. Results of SASRT and FFD test are highly correlated with r value above 0.7 in every case.

In more specific level of analysis, I assessed differences between extreme values of coefficient of variances. Highest assessed value in every exanimated relation was high (around 80%), but in a case of SABS the lowest result was showed directly after end of exercises (more than 60% lower). Results of FFD and SASRT differs on similar level between extreme values. This large diversity between values of this variable in SABS do not allow to conclude that it is reliable assessment tool during physical effort.

SABS test is not recommended assessment tool for coaches and physiotherapist. The same attentions are pointed towards FFD test. In SASRT, in a difference of using vertical stance, in sitting position one's own finger can be used as a scale which is always the same. It also measures in accuracy to around 2 cm, which stands for normal width of one finger. In a standing position, it is impossible to use such accurate scale as in SASRT without an assistance of observer. Non-apparatus test in sitting position fulfill criteria of reliability and is presenting higher sensitivity than modified finger-floor distance test.

SASRT, because of its sitting posture during assessment is safer for elderly, whom different forms of sport and recreational activities are recommended. There is none risk of fall because of balance loss of elder or disabled person. Those people can also train judo, because this martial art do not have any age [15] or psychomotor [16] limitations.

Self-assessment of flexibility does not replace physical examination performed by therapist, but learning assessment methods and motivation patients to monitor their own health state and process of improvement should positively affect his motivation and encourage to undertake responsibility of their own motor development. If training person would have essential knowledge and simple assessment tools for monitoring basic indicators of positive health (countable to points), it is more likely that cooperation with personal coach or health training expert might be more effective [17, 18].

Without necessity of using any apparatuses to make an assessment it allows to use that test also by visually impaired people. Sitting posture is safe for them and the way of assessing flexibility allows them to read the result by themselves [9].

This study was conducted in January, so in the middle of training season of academic youth society in Poland. In previous training sessions of tested persons there were also no special exercises for improving flexibility. Despite that, those judo amateurs were characterized by extraordinary level of flexibility, which was proven by results of all applied test. Maintaining high level of flexibility of people who practice judo (without special exercises for flexibility improvement) was established by Katralli et al [19].

According to Arndt-Schultz rule [20], incentives on moderate intensity will stimulate organism. High level of flexibility of judokas without additional stretching exercises indicates that intense training with elements of wrestling type of fight (throws, tumbles, grappling, controlled falls etc.) allows to maintain flexibility on high level with minimal rigor of two training sessions per week. Training sessions of tested sportsmen have recreational character. They are not athletes with long training experience with perspective of high sport achievements (sport championship). They treated judo as sport of life, health training based on elements of judo and fun forms of martial arts [21]. The eldest tested judoka was 40 years old.

There are study results which indicates that intensive static stretching exercises before training are connected with decrease number of maximal possible repetitions of exercise performed by training sportsmen [22]. At the same time, stretching exercises that last longer than 45 seconds will reduce maximal potential muscle power while performing such motor activities like high jump [23]. That is why those kind of exercises should not be a part of motor preparation for physical effort where there is element of competition. This conscious reduction of muscle strength as a result of stretching exercises during warm up will be justified (as a side effect) from perspective of reducing risk of injury. Studies results showed though, that there are no connections between performing stretching exercises before training with injuries of soft tissues during this training [24, 25]. In a case of combat sports, which belong to a group of high risk of injury, it is justified to maintain high level of flexibility for contusion prevention during training sessions or competitions. That is the reason why it is recommended to check flexibility level before and during any kind of physical training.

CONCLUSIONS

1. State of body stimulation during judo training session have no connection with changes of flexibility level of tested amateur judokas.

2. FFD and SASRT tests fulfilled criteria of validity and reliability as an assessment tools for measuring flexibility in a normal state of daily activity, as well as in increased state of body stimulation in different training situations. SABS test is not recommended, because it did not fulfill assumptive criteria of validity and reliability.

3. The most prognostic application in training and therapeutic practice is exhibited by SASRT, because it not only fulfills criteria of validity and reliability, but also it is the safest applied test.

COMPETING INTERESTS

Author has declared that no competing interest exists.

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