

Effect of preferred body stance side on the performance of Special Judo Fitness Test in Japanese judo athletes

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- A Study Design
- B Data Collection
- C Statistical Analysis
- D Manuscript Preparation
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Abstract

Background & Study Aim: This study aimed to further knowledge of: 1) body stance side preferred in performing tachi-waza (fighting in standing position); 2) level of fitness preparation of males and females; 3) effect of the dominant body side on the quality of performance in SJFT and the effort perceived.

Material & Methods: Paired selection helped obtain the consistency of the characteristics of 9 male and 9 female subjects in terms of age (Males 18.0±2.3 vs. Females 17.2±2.3 years), training experience (9.9±1.7 vs. 10.7±2.9 years), sports skill level (1-2 dan) and another weight category. A dominant fighting stance (right or left) was determined. In another two days, the randomly selected subjects performed SJFT with the dominant and non-dominant body side. The data grouped according to the body side formed the condition factor. The analysis used non-parametric statistical tests. The differences were tested at the significance level set at $p < 0.05$.

Results: Distribution of the group sizes for left- and right-sided subjects in groups of males and females did not differ ($p=0.667$). Performing the throws in series A of SJFT with the dominant vs. non-dominant body side showed significantly better results in males ($p=0.030$), but not in females ($p=0.424$). Evaluation of the similarity of performing SJFT with the non-dominant body side in a judo bout during competition was significantly higher in males compared to females ($p=0.015$).

Conclusions: The throws used during SJFT are most frequently performed using the dominant compared with the non-dominant body side, but the females are characterized by a specific pattern of performing consecutive series of SJFT compared to men. Women feel higher fatigue when performing the test using the non-dominant body side.

Keywords: functional laterality • muscle fatigue • physical fitness • sex

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Kumikata – the way a judoists maneuvers to obtain a grip on his opponent sleeve, collar, and / or lapel in the process of building an offence and defence, including more general aspects of positioning including right or left approach, natural or defensive posture [28].

Aiyotsu – face off with matched stances. When opponents in a match or practice session engage one another using the same left or right grips, referred to as left aiyotsu or right aiyotsu depending on which side is forward [28].

Shiai – a judo match or bout, generally governed by specific rules for the purpose of awarding points and determining a winner [28]

Time-motion study – an analysis of a specific job in an effort to find the most efficient method in terms of time and effort

Random – lacking any pre-arranged order, as if due to pure chance [29]

Sexual differences – in sport, differences in sporting performances and participation between males and females which may be due to cultural, physiological, biochemical or hormonal distinctions [29]

Phosphocreatine (Pcr) – an energy-rich compound used in production of ATP from ADP in muscle. The breakdown of creatine phosphate to creatine and inorganic phosphate is ergogenic reaction coupled to synthesis of ATP [29]

INTRODUCTION

Undoubtedly, a tournament judo bout (shiai) represents the best test of sports skill level of a contestant and various aspects of its preparation: technical, tactical, motor, psychological and theoretical [1]. Contemporary studies suggest intensified sexual dimorphism in body build and composition of judo practitioners [2, 3]. Statistically significant morphological differences have also been documented between weight categories in men [4] and women [5]. Both groups compete within seven weight categories i.e. -60 kg, 66 kg, 73 kg, 81 kg, 90 kg, 100 kg, over 100 kg and -48 kg, 52 kg, 57 kg, 63 kg, 70 kg, 78 kg, +78 kg, respectively. A judo bout starts in a standing / vertical position and can be continued in the horizontal position / groundwork and represents an intermittent exercise according to sports regulations [6]. Small differences were observed in the senior categories between the duration of characteristic phases of individual men's and women's bouts (time motion analysis) in total combat time (30 s vs. 35 s), displacement without contact (5 s vs. 7 s), gripping time (14 s vs. 13 s), standing combat time (24 s vs. 27 s). Greater differences occur between groundwork combat time (15 s vs. 8 s) and pause time (11 s vs. 6 s) [7, 8]. Sexual dimorphism index (SDI) [9] evaluated by us for the above mentioned parameters concerning fighting in the vertical stance where performance of throws is permitted is not big, respectively 0.83, 0.60, 1.08 and 0.88. During the bout (vertical stance), where throws are used, lateralization of technical and tactical activities is also important [10], since greater number of throws used [10] and attack performed in more than two directions is conducive to surprising the opponent [8, 11]. During the intermittent exercise that consists in repeated throws (Ippon seoinage), as it is the case in the Special Judo Fitness Test (SJFT), the major effect is from the anaerobic alactic energetic system and aerobic capacity [12]. SJFT has been demonstrated to be a useful tool for control of training effectiveness and during in the experiments in various countries since the results obtained in the test allow for an accurate quantification of performance and can then be evaluated and compared with normative values for men and women [13, 14]. No publications have documented the results obtained from the experiments carried out in Japan that answered to the question: „Which differences can be observed in performance of SJFT between the dominant and non-dominant body side?“

CONCEPT OF THE STUDY

Due to the division into weight categories of men and women, their strength abilities are similar. The results obtained in SJFT will be more determined by

technical and tactical preparation and physical capacity rather than strength. SJFT, with the effort similar in its temporal structure to a judo bout, consists in repetition of typical judo throws. This effort is of mixed anaerobic and aerobic character [12].

The aim of the present study is: (1) determination of the stance preferred in Tachi-waza (combat in standing position); (2) evaluation of the effect of the dominant body side on the quality of performance in SJFT; (3) diagnosis of fitness preparation of male and female judo practitioners in Japan.

The following hypotheses were proposed:

1. Regardless of gender, the subjects will frequently include contestants fighting in left dominant body stance.
2. Throws performed at a specific time will be performed more frequently using the dominant rather than non-dominant body side.
3. Competitive level and gender might affect the pattern of results and feeling of fatigue during SJFT performed with involvement of dominant and non-dominant body side.

MATERIAL AND METHODS

Subjects

The subjects gave their consent to participate in the study. No-adults obtained the consent from their parents or legal guardians. The project was accepted by the Local Bioethical Committee (No. 14-14).

The criterion for inclusion into the study group was previous participation in tournament bouts and no injuries/ body damages that would limit normal performance of judo exercises. The experiment was carried out in the preparation period. Based on the results obtained from 9 females, we used a method of paired selection with 9 males according to age (years), training experience (years), advancement level (dan) and weight category (for instance, the women's category up to 48 kg corresponded to the men's category of up to 60 kg). Both groups were at similar age (Male=18.0±2.3 years vs. Female= 17.2±2.3 years), had similar training experience (9.9±1.7 years vs. 10.7±2.9 years) and advancement level (from 1 to 2 dan). Male and female won places in national tournaments (2 and 6), regional tournaments (0 and 2) and prefecture tournaments (7 and 1). These groups differed in their body height (170.2±3.8 cm vs. 157.8±4.2 cm), body mass and body mass index (BMI) (26.8±4.7 kg/m² vs. 24.5±4.6) kg/m²).

PROCEDURE AND MEASUREMENTS

Anthropometry

All the subjects filled the questionnaire concerning demographic characterization. The basic measurements of physical development (body height and mass) were performed using an electronic scales (Tanita, Digital Health Meter HD-662, Japan) and stadiometer (seca, seca213, Germany) and then BMI was calculated (kg/m^2). Age was evaluated based on the date of birth given in the demographic questionnaire.

Special Judo Fitness Test

On the first day of the study, each subject, after demonstration of the stance preferred in a judo bout (right or left), was randomly assigned the method of performing a throw (from the right or left fighting stance). On the second day, during SJFT, the same subjects performed the throws in the opposite direction. This ensured that the order of performing the throws with the dominant or non-dominant body side that would have affected the results was unimportant, since all the subjects randomly performed throws in both directions.

Special judo fitness test was carried out following the standardized warm-up procedure according to the instruction described by [13]. The video instruction is available online at [15]. The cards of individual experiments contained the number of throws performed within the 15-second segment A, 30-second segment B, and 30-second segment C. Duration of the rests between the segments was 10 s. The measurements of a minute heart rate (bpm) were recorded directly after the exercise and after a 1-minute rest using a heart rate monitor (Polar, RS800CX, Finland).

The SJFT index was calculated according to the following formula: $\text{SJFT Index} = \text{Final HR (bpm)} + \text{HR 1 min (bpm)} / \text{Throws in total (N)}$ (equation 1)

where:

Final HR – heart rate recorded immediately after the test.

HR1 min – heart rate obtained 1 minute after test.

Throws – number of throws completed during the test.

Lower index represented better results.

Furthermore, the subjects answered to the question of the similarity between the effort perceived in the SJFT and during real competition. They used a 5-point forced-choice scale (1-minimum, 5-maximum).

STATISTICS

Statgraphics Centurion software (version XVI) was used for calculations. The results obtained from SJFT were ordered according to the condition factor (dominant body side, non-dominant body side). Fisher exact test was used for comparison of frequency of body stance preferred in judo bout by male and female judo athletes. The mean values, standard deviations and medians (Me) were also presented. Non-parametric methods of comparison in groups (condition factor) and between the groups (gender factor) were used since not all the dependent variables (SJFT results) showed a normal distribution (Shapiro-Wilk test). Based on the differences in performance of SJFT with involvement of either dominant or non-dominant body side, we compared the results of measurements using signed rank test. This test is based on comparing the average ranks of values above and below the hypothesized median. SJFT performed in different experimental conditions represents the response of the group of male (M) and female (F) subjects. Mann-Whitney (Wilcoxon) W-test was used for comparison of Me values. The interpretation was carried out with regard for the fact that the groups did not differ in age, training experience and weight category, which, however, did not concern the competitive level, which was higher in women. The best result obtained by 6 women was places from 1 to 9 in national-level tournaments, whereas in the group of men, only two subjects took places in the tournament of this high level. The statistical hypotheses concerning the differences between medians were verified at the level of significance of $p < 0.05$.

RESULTS

The most of the subjects in both groups preferred the right vertical body stance used in a judo bout (Table 1).

Table 1. Frequency Table

	Right Stance	Left Stance	Row Total
Male	5	4	9
Female	6	3	9
Column Total	11	7	18

Distribution of the group size in the groups of men and women did not differ (Fisher exact test $p = 0.667$). The contribution of left-sided subjects among the respondents was 0.39.

Results of performing SJFT for groups compared in different experimental conditions were presented in Table 2.

Table 2. Special Judo Fitness Test performance by dominant vs. non-dominant body side of Japanese athletes (mean \pm SD; Median)

	Dominant	Non-dominant
Throw series A (n)	5.9 \pm 0.5; 6.0	5.4 \pm 0.7; 5.0*
Male (n)	6.1 \pm 0.6; 6.0	5.2 \pm 0.7; 5.0*
Female (n)	5.8 \pm 0.4; 6.0	5.6 \pm 0.7; 5.0
Throw series B (n)	10.8 \pm 0.8; 11.0	10.3 \pm 1.2; 10.5
Male (n)	10.7 \pm 0.7; 11.0	9.9 \pm 1.0; 10.0
Female (n)	10.9 \pm 0.9; 11.0	10.8 \pm 1.2; 11.0
Throw series C (n)	10.0 \pm 1.0; 10.0	10.3 \pm 1.1; 10.0
Male	9.9 \pm 0.9; 10.0	10.0 \pm 1.3; 10.0
Female	10.2 \pm 1.1; 10	10.6 \pm 0.9; 11.0
Total throws (n)	26.8 \pm 2.0; 27.0	26.0 \pm 2.7; 25.5
Male	26.7 \pm 1.8; 27.0	25.1 \pm 2.6; 25.0
Female	26.9 \pm 2.3; 27.0	26.9 \pm 2.6; 27.0
HR directly after (bpm)	183.6 \pm 7.4; 182.5	183.2 \pm 9.7; 183.5
Male	184.9 \pm 7.6; 183.0	180.8 \pm 10.9; 182.0
Female	182.3 \pm 7.2; 182.0	185.6 \pm 8.3; 185.0
HR 1 minute after (bpm)	152.1 \pm 12.0; 153.5	150.0 \pm 10.5; 151.0
Male	153.0 \pm 10.4; 153.0	148.2 \pm 10.5; 148.0
Female	151.1 \pm 14.0; 155.0	153.4 \pm 10.6; 152.0
Index	12.60 \pm 1.13; 12.60	12.96 \pm 1.38; 12.95
Male	12.72 \pm 0.99; 13.00	13.20 \pm 1.26; 13.10
Female	12.50 \pm 1.30; 12.40	12.72 \pm 1.52; 12.80
Effort (points)	3.2 \pm 1.0; 3.0	3.4 \pm 1.0; 4.0
Male	3.1 \pm 1.3; 3.0	2.9 \pm 1.3; 3.0
Female	3.3 \pm 0.7; 3.0	4.0 \pm 0.5; 4.0†

*difference Non-dominant from Dominant body side, †differences Female from Male

In general, the number of throws performed using the dominant body side was from 5 to 7 (5.9 \pm 0.5; Me=6) and was higher than the same number for the non-dominant body side (signed sign test=2.432, $p=0.015$), where it was from 4 to 7 throws (5.4 \pm 0.7; Me=5). In men, the number of throws using the non-dominant body side was significantly lower than for dominant body side (signed sign test=2.163, $p=0.030$), which was not observed in the female group (signed sign test=0.8, $p=0.424$). The direction of differences between the number of throws in series B and C performed using the dominant body side was similar than in men. The differences were not statistically significant. Performing the throws with the non-dominant side confirmed this

tendency with exception of the results obtained in the series C in women. Consequently, the difference in total throws performed in SJFT was higher in men (2) and did not occur in women (0). The differences between HR and Index values were not statistically significant after performance of SJFT with the dominant or non-dominant body side.

Males and females evaluated the perceived effort during SJFT test at the similar level when performing the test using the dominant body side compared to the effort experienced during a tournament bout, from 1 to 5 points and from 2 to 4 points, respectively. Their rating of the effort during performance of SJFT with non-dominant body side compared to fighting during competition differed significantly ($W=15$, $p=0.015$), with the results being Male=2.9 \pm 1.0, Me=3.0 vs. Female=4.0 \pm 0.5, Me=4.0, respectively.

DISCUSSION

As we expected, due to the popularity of judo in Japan, the contestants using the left body side will be more frequently represented in the test. Our study demonstrated that the Hypothesis 1 (Regardless of gender, the subjects will frequently include contestants fighting in left dominant body stance) was supported with the distribution of the group size (Table 1). The contribution of the left-sided subjects was 39% and was similar to the group of medal-winners in an international-level judo tournaments [10], and higher than to noninteractive sports (10–14%) [15]. These judokas are characterized by a more symmetric profile (more equalized percentage of techniques used in different directions of attack compared to the right-sided athletes). Therefore, the contestants using the left body stance (dominant stance) are less predictable in action, which is conducive to their success during a judo bout [10, 11, 17].

It was essential in this study to demonstrate the interactions of the experimental condition factor with the gender of the subjects. The main outcome of this study was showing the differences in performing the throws with the dominant side compared to the non-dominant body side during the segment A in SJFT. It also turned out that this phenomenon was more intensified in the group of female subjects. Similar potential expressed by double number of throws performed in segment A was observed in both women and men (this index i.e. A*2 has also been used in previous studies [18]) and a decreased number of throws (Me) in consecutive segments of SJFT performed with the dominant body side (Figure 1).

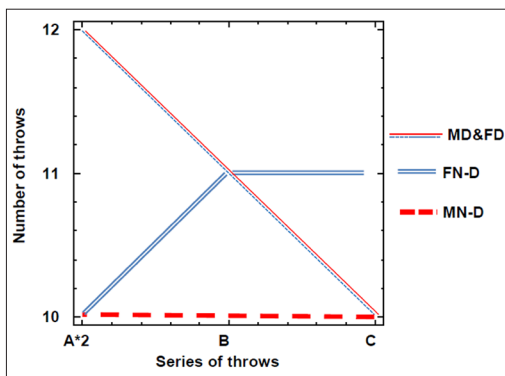


Figure 1. Pattern of performances of SJFT observed in male and female judokas. MD & FD -male and female dominant side; FN-D – female non-dominant body side; MN-D – male non-dominant body side.

This decline was not observed, however, in the test using the non-dominant body side by men, where the level of performance in the series A was lower. In women, the potential that manifests itself in the first series of throws ($A*2=10$) was paradoxically lower than in the next series ($B=11$ and $C=11$). The factor which is likely to affect the interaction is higher competitive level of women compared to men and higher symmetry of technical and tactical actions. Other studies have demonstrated that achievements of men in national-level tournaments are correlated with results obtained in SJFT [18]. Furthermore, performance of SJFT depended on the age category (female cadets, juniors, seniors) [19] and, in both gender groups, on the level of aerobic and anaerobic capacity [19, 20].

A potential reason for the observed greater number of successful throws on the dominant vs. non-dominant side (see Table 2) could be a difference in the high energy phosphate concentration (mainly phosphocreatine PCr concentration) in the main skeletal muscles involved in a given throw, i.e. higher PCr concentration in the muscles of the dominant side. However it has been shown [21] that muscle PCr concentration as well as phosphorylation potential ($\Delta GATP$) levels at rest in dominant vs. non-dominant legs in athletes are similar [21]. Therefore the difference in PCr and $\Delta GATP$ in the muscles of the dominant and non-dominant sides cannot account for the observed phenomenon of more successful throws on the dominant side in the first 15 seconds of a bout (series A). Potential explanation of this phenomenon could be higher muscle efficiency developed by years of practising throw movement on the dominant side. In this case more efficient muscle could perform the task (throws) using less

energy and allowing the athletes to perform more successful throws in the early stage of fight. However the excessive usage of the dominant side is likely to develop, after several years of training, an endurance-like muscles phenotype [21] resulting also in a decrease in resting muscle PCr store [21] which could be a limiting factor for generation of required throws at high speeds.

An additional explanation that justifies evaluation of normative values in SJFT for women [14] was "increased resistance to fatigue and faster recovery of power in women compared to men during repeated intermittent efforts" [22]. Greater contribution of the aerobic system, lower depletion of phosphocreatine stores and adjustment of neuromuscular strategy of women was partially responsible for different results in SJFT [23–25]. Absolute mechanical work during the first exercise in the intermittent effort might be correlated to sexual dimorphism [26]. Therefore, it seems justified that „During the SJFT, greater mechanical work during the active throwing periods would therefore impact performance via altered recovery and fatigue patterns throughout the testing procedures" [14].

Although in this study we focused on a statistical comparison of the average values, it also seems justified to use normative values of SJFT for evaluation of the differences in the male group [13] and separately for women [14]. The men in the study obtained „good" score for the number of all throws performed, post-exercise HRs in both testing conditions but also „poor" for total throws and „average" for Index when performing throws using the non-dominant body side. Furthermore, the women for whom using age tables was possible obtained „excellent" for the number of throws and Index value and „regular" for post-exercise HRs.

The experiment demonstrated the substantial differences in response between male and female body to performing SJFT. Attracting the attention to the differences present in the series A of this test represented the basis for attempting to explain the causes of this phenomenon in light of available literature. The factor which limits obtaining a clearer presentation of the gender effect and contribution of either dominant or non-dominant body side during throws was higher competitive level in women and men. We have accepted the theory by Haag et al. [27]. Therefore, in practical applications, the results of SJFT can be compared individually (during development of an individual through training process

and competitive activity), within a group (according to gender or competitive level), with other groups (e.g. juniors vs. seniors), with relative norms or with absolute norms. Therefore, in order to compare the results of these studies further within the problem presented, it seems purposive to carry out experiments in the national team.

CONCLUSIONS

1. A high number of contestants using the left dominant body stance occurs among both male and female athletes. Kenka-yotsu allows for using specific gripping techniques and angles of forceful

affecting the opponents, thus deciding on the effectiveness of throws.

2. In general, the throws used during SJFT are most frequently performed by the dominant compared with non-dominant body side, but the females are characterized by a specific pattern of performing consecutive series of SJFT compared to men. Women feel higher fatigue when performing the throws using the non-dominant body side.

COMPETING INTERESTS

The authors declare they have no competing interests.

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