

# Work-to-rest ratio during three repeated judo struggles separated by short intermissions. A preliminary study

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**Key words:** males, judo, repeated struggles, work-to-rest ratio

## Summary

**Introduction.** In a single full-time judo struggle played by a male player lasts 5 minutes of active work, with excluding total time of rest periods, when a referee aborts a struggle. Thus work-to-rest is the factor showing both judging and fighting style. The aim of this study was to confirm hypothesis, that severe muscle fatigue may shifts work-to-rest ratio toward a lower values.

**Material and methods.** Six senior male judo players were grouped into three pairs, which played repeated three full-time 5-minute judo sparing matches separated by 10-minute passive intermissions. The struggles were judged by the same referee. Total time of each struggle lasted 5 minutes of active combat with stoppage time of rest periods. Additional comparable observation was conducted during official judo tournaments, where each of six judokas played at least one full-time fight.

**Results.** For 1<sup>st</sup> and 2<sup>nd</sup> struggle work-to-rest period were comparable,  $2.27 \pm 0.42$ ,  $n=6$ , while for 3<sup>rd</sup> struggle was lower  $1.60 \pm 0.07$ . We suspect that lower work-to-rest ratio and higher sum of rest times resulted in higher frequency of these situations during 3<sup>rd</sup> game, which forced a referee to abort combat. During an official full-time struggle the mean total time was somewhat shorter, thus, work-to-rest ratio was somewhat higher 2.78 as compared to those values of sparing fights

**Conclusions.** Successive repeated intensive judo sparing bouts with short rest intervals between them change work-to-rest ratio toward lower values.

## Introduction

It is known, that an exertion of high intensity leads to fatigue of working muscles and to the deterioration their physical abilities. That phenomenon was especially noted during intensive and continues effort, for instant during Wingate test. At the end of that exertion lasting 30s the value of power output is always lower as compared to that recorded as peak power, reached few second after the start. That relative, percentage of power lost is expressed as fatigue index (FI). The study showed, that peak power and the maximal accumulated O<sub>2</sub> deficit were highly and significantly correlated and ability to maintain power output during a 30-s cycle sprint is related to anaerobic capacity [1]. Furthermore, the lost of maximal power is fitted by an exponential curve [2]. Among power athletes mean FI reaches almost 49% with absolute peak power amounting over 1000 Watt, and over 12.0 W/kg after its

normalization to body mass [3]. Impairment of maximal power output has been found also in successive repeated "all-out" bouts, when the length of intermissions for rest is too small to reach full state of recovery prior to the next bout. In such cases the performance levels of consecutive exertions become more and more lower, even despite of previously loading by various pharmacological enhancers [4-8]. Long since it has been evidenced, that rate of post-effort recovery of cellular phosphagens (PCr, ATP) play a crucial role in a rise of ability to generate again maximal, initial power output, while the depletion of the phosphagens is responsible for temporary impairment of the power. Obviously, there are also the other metabolic and physiological factors contributing to voluntary post-effort state of fatigue and rate of recovery and to the equilibrium between those two processes. These issues are taken into consider, when scheduling interval training session [9]. During intermittent exercises work-to-rest ratio influences

not only on physical performance, but also on metabolic and perception of entire exercise [10,11]. For that reason, during a prolonged competitive effort athletes of various sports, soccer player [13] football players [14] and runners [15-17] athletes have individual specific pacing strategy for sustain their optimal physical abilities to avoid premature exhaustion.

An official judo struggle is the type of acyclic effort characterized by series intensive dynamic and static offensive and defensive actions interspersed with short passive rest periods. Those intermissions is controlled by the judge in a case, when the fighting judokas cross a borderline of the contest area, to correct a belt of judo uniform (judogi) or in a case of a situation not leading to settlement of the results of the action. We expect, that very fatigued judo contestants may consider the statutory, situational intermissions as opportunities to partial power recovery. In fatigued judokas we may observe less vigorously performed actions, lower rate of real attacks and counterattacks, simulated attacks or avoidance of intensive fighting. However, that behavior may be considered by a judo referee as passive behavior leading to the penalty (*shido*). Thus, sometimes judo contestants use the other ways for extension of time of rest. We may observe, that after a not resolved the action of a ne-waza action (ground effort), rising from a ground and correcting their uniforms look like in a slow motion. Moreover, high number of these episodes may be responsible for lowering work-to-rest ratio, especially at the end of competition.

This study was aimed to induced general fatigue (lower vigor) by three, consecutive, judged sparing contests, each lasting full-time (5 minutes of a active combat) regardless of predominance and recorded scores or successful use of any action ending a match

## Material and methods

Examined group consisted from six senior male judo players of comparable skill levels and various weight categories participating in a 2-week training camp. In the half of this peri-

od judokas were grouped into three pairs of fighting opponents according to their body mass. Judokas played three full-time (5 minutes) consecutive sparing matches with 10-minute passive intermission between each exertion. All the matches were played during afternoon session after normal warm up of individual intensity performed prior to the 1<sup>st</sup> struggles. Post-exertion recoveries were passive. Each sparing was judged by the same highly experienced male referee. The struggles were continued up to completing full-time of fight, regardless of the predominance one of the performer in scores or making of successful technique that usually ends an official struggle. Total time of struggle, sum of active combat and pauses were also recorded. The same players were observed during an official judo tournament, and time-profile of the struggle was recorded, when it lasted also full-time.

## Results

The time-profile results of recorded activity profiles in three consecutive sparing judo struggles are displayed in Table 1. Time profile of the one official struggle recorded in 6 judokas is displayed in Table 2.

In this study total time in 8/9 sparing struggles exceed 7 minutes. It means, that sum times of rest periods somewhat exceed 2 minutes. For 1<sup>st</sup> and 2<sup>nd</sup> struggle the time of pauses and in consequence values of work-to-rest ratio fluctuated within each couple and directions of the changes were vary. The time of struggle and sums of pauses was longer for the 3<sup>rd</sup> exertion as compared to those earlier for each of the pair of contestants. Total time of the 5-minute official struggles was somewhat shorter and in a consequence, work-to-rest ratio was a little bit higher, but the differences tested with the use of U Mann-Whitney test were not significant ( $p=0.173$ ). Moreover, there were no effect of previous struggles on the time-profile of full-time struggle. We suspect, that lower work-to-rest period of 3<sup>rd</sup> sparing fight may be induced by accumulation of fatigue following previous two struggles and, in part, of lower motivation to engagement in a maximal bout.

Table 1. Total time (seconds) of consecutive struggles and work-to-rest ratio (300s-to- time of pauses ratio) in three pairs of the contestants

sparing struggle	total time of struggle				work-to-rest ratio			
	pair A	pair B	pair C	average A,B,C	pair A	pair B	pair C	average A,B,C
1 <sup>nd</sup>	448	415	484	449	2.02	2.61	1.64	2.09
2 <sup>nd</sup>	420	442	409	424	2.50	2.11	2.75	2.45
3 <sup>rd</sup>	489	495	479	488	1.59	1.54	1.68	1.60
average	452	450	457	454	2.04	2.08	2.02	2.05

Table 2. Total time and work-to-rest ratio in the official struggle lasting full-time and work-to-rest ratio recoded during high rank competition in six examined judokas

profile of time	contestants							
	a	b	c	d	e	f	X	SD
total time	405	447	419	395	428	379	412.2	24.3
work-to-rest ratio	2.85	2.04	2.52	3.16	2.34	3.80	2.78	0.63
number of previous played official struggles	1	2	4	3	2	3	-	-
total time of previous played official struggles	0	542	782	623	412	588	-	-

## Discussion

As mentioned earlier a single match of martial arts/combat sports is not a continuous- but an intermitted effort. The equilibrium between active phase (fighting) and non-active ones (no fighting and stoppage time) were extensively studied mostly in taekwondo contestants. Considering only active phase of this contest, there are very easy to distinguish two basic types of motion, attacks and skipping, and ratio of total time of attacks: total time of skipping was ca. 1:7 and it was somewhat lower during the World Championship than Olympic Games. Moreover lack of consistent differences in relation to body mass was found during OG, but during the WCh heavier players demonstrated lower activity as compared to the lighter counterparts [18]. More comprehensive studied among cadet taekwondo players (13-14 ys) showed that total time of fighting phase, non fighting time and stoppage time accounted 42.4, 44.5 and 13.1% of entire time of the matches regardless both sexes and various weight divisions [19]. During short-lasting karate fight (*kumite*) total time of effort to total rest ratio expressed in seconds was 10.0s: 11.9s, however, taking into consider only time of the highest intensive actions 1.6s that ratio was consistent lower. Moreover time profile of simulated and official contest were differ, because of lower time of activity during an official match [20]. Interestingly, among male karakas there were no differences between winners and defeated players [21]. Time-motion analysis was conducted in relation to the stances, standing combat time and groundwork time. In this study ratio of high- to-low intensive actions +pauses in entire matches ranged from 1:4 to 1:5, while time of ground exercises was related to number of round [22].

To our knowledge, there are only two up-to-date studies by Miarka et al which explored profiles of activity during judo matches. The first study [23] was conducted on vast sample of the athletes from various age division, from pre-juvenile (13-14 y) to seniors (>20 y). Assuming classification of various motion/stances types, total combat, standing combat, displacement without contact, ground combat, gripping and pauses, it was found age-dependent time of mentioned above indicators. Similar exploration was published two years later only for female judokas and the finding was similar to that previously reported [24].

Up to date our study is the only which examine effect of putative state of non-full post-second match recovery on work-to-rest ratio. We assumed, that fatigue accumulation resulting in very short intermissions between intensive exertions may affects longer time of pauses throughout 3<sup>rd</sup> match. Despite of low sample size and in consequence lack of statistical evidence our assumption seems to be confirmed, however the effect is no very clear. It is worth to note, that in our study mean work-to-rest ratio was lower than that recorded by Nilsson J

et al [25] during Greco-Roman Wrestling World Championship, where mean active combat lasted 317s, sum of pauses was 110s and W-to-R ratio was 2.88. Moreover, contrary to our finding, during the wrestling tournament mean time profile of the first- round matches and the final-round ones did not differ, that suggests either lack of severe accumulation of fatigue over the time course or/and such vast motivation that allow to overcome, in part, the effect of fatigue.

It is worth to note, that In our experiment sparing judged matches could not cause so strong motivation as that appearing itself during a high rank competition. During an official judo tournament finalists have to played up to 5-6 matches per day, but not all of them last full-time, and only in the final phase very short intermissions between them (10 min) can happen. For that reason, during competition, there were no effect of "fatigue" induced by previous struggles. Another explanation is that times of previous official struggles were shorter, and mean intermission between them were longer than those imposed during sparing fights.

Summing up we suspect, that lower work-to-rest period of 3<sup>rd</sup> sparing fight may be induced by both accumulation of fatigue following previous two sparing struggles and, in part, by lower motivation to engagement in a maximal but non competitive bouts. That issue, however, merits further investigations.

## Study limitations

Although all 9 judo matches were judged by the same referee, we cannot exclude some minor errors or to guarantee strictly the same style of judging, especially repeatability of decision-making regarding when and which action should be aborted.

We ignored the fact, that the extent of engagement and motivation to sparing struggles among examined judo may be differ and that may influence on their behaviour.

Because of lack of a detailed recorded individual activity, especially type and number of and non-successful offensive action, it is also hard to rate the individual contribution of the behaviour leading to enforced pauses.

## Conclusions

1. Sparing full-time judo matches separated by 10-minute intermissions lead to the increase of total time of pauses and lowered of work-to-rest ratio in the 3<sup>rd</sup> match, that may be induced by accumulation of lowered physical vigour and general physical abilities following two successive fights.
2. Official full-time judo matches lasted shorter than those sparing ones and their work-to-rest ratio is higher, thus, it seems, they are played more vigorously.

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Received: 12.02.2014

Accepted: 26.05.2014