Monitoring training during four weeks of three different modes of high-intensity interval training in judo athletes

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

Braulio Henrique Magnani Branco[1,2BCDE], João Paulo Lopes-Silva[2BCD], Jonatas Ferreira da Silva Santos[2BCD], Ursula Ferreira Julio[2ABDE], Valéria Leme Gonçalves Panissa[2ABD], Emerson Franchini[2ACDE]

[1] Department of Physical Education, University Center of Maringá (UNICESUMAR), Maringá, Paraná, Brazil
[2] School of Physical Education and Sport, University of São Paulo (USP), São Paulo, Brazil

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Abstract

Background and study aim: Ideal control of training load and physiological recovery between training sessions and competitions are important aspects for training periodization and improve performance in competition. The aim of this study was the effects of 4-weeks of three different modes of high-intensity interval training (HIIT) on the heart rate variability (HRV), as well as perceptual, physiological and psychometric responses among judo athletes.

Material and Methods: Thirty-five judo athletes were randomized into three training groups: 2 blocks of 10 sets of 20s all-out effort by 10s recovery twice a week using lower-body [high-intensity exercise (HIE) in cycle-ergometer for lower-limbs with 4.5% of body mass]; upper-body (HIE in cycle-ergometer for upper-limbs with 3% of body mass); *uchi-komi* (HIE by means of technique-entrance) and a control group (judo trained only). The HRV was monitored at rest at the beginning of each week. The frequencies analysed were the root mean square of successive differences in the R-R intervals (rMSSD) and rMSSD/MRR (mean of R-R intervals) ratio. Blood samples were collected to measure hormone concentrations [free-testosterone and cortisol] and cellular damage markers [creatine kinase (CK), lactate dehydrogenase (LDH), aspartate aminotransferase (AST) and alanine aminotransferase (ALT)] before and after the training period. The ratings of perceived recovery (RPR) and exertion (RPE) were reported in each HIE-session. The psychometric questionnaires were applied weekly.

Results: There was no difference for HRV, RPE, internal training load, psychometric questionnaires, hormonal levels, CK, AST and ALT ($p>0.05$). There was a moment effect for the *uchi-komi* group, with higher values for RPR in the first HIE-session when compared to the second ($p = 0.014$) and an increase of LDH to the upper-body group ($p = 0.031$) after 4-weeks.

Conclusion: Thus, low-volume HIIT promoted only a moment effect for RPR in *uchi-komi* group and an elevation of LDH in the upper-body after 4-weeks.

Keywords: combat sports • fatigue • physiological recovery • sports performance

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Author's address: Braulio Henrique Magnani Branco, Av. Bento Munhoz da Rocha Netto, n° 1014, apto 74, bloco A, Zona 7, 87030-010 Maringá, Paraná, Brazil; e-mail: brauliomagnani@live.com

Combat sport – *noun* a sport in which one person fights another, e.g. wrestling, boxing and the martial arts [38].

Muscle fatigue – the transient decrease in performance capacity of muscles, usually evidenced by a failure to maintain or develop a certain expected force or power [39].

Sports performance – refers to the results achieved within the sporting context.

Physiological recovery – concerns strategies used for maintain optimal sports performance.

Training intensity – the effort of training. A number of methods are used to establish training intensities which give maximum benefits. These include the blood lactate method, minute ventilation method, and target heart-rate [40].

INTRODUCTION

Ideal control of training load and physiological recovery between training sessions and competitions are important aspects for training periodization and improve performance in competition [1]. Components such as heavy training loads, coupled with inadequate physiological recovery of athletes, can diminish performance, cause injuries and bring about states associated with non-functional overreaching and overtraining [2]. The control and monitoring of training requires saliva collection [3], venous blood [4], rating of perceived exertion (RPE) [5] and recovery (RPR) [6], psychometric questionnaires [7, 8], heart rate variability (HRV) [9] and performance tests [10]. However, evaluation by means of saliva and venous blood present limitations, such as the high cost of kits, the need for analyses in laboratories and vein puncture.

Conversely, the use of HRV, psychometric questionnaires, RPE, RPR and performance tests are practical, accessible and reliable means for monitoring and controlling the training process, as long as they are used concomitantly [11]. In fact, the autonomic nervous system (ANS) seems to be sensitive to changes in training load during different practice periods [12], in which moderate loads promote an increase of indices related to vagal activity [13]. On the other hand, the intensification of training for judo athletes reduced these indices [10]. There are no reference values in ANS for detecting conditions associated with functional and non-functional overreaching or overtraining in judo athletes. Thus, it is necessary that athletes be constantly monitored in order to identify the reference values for each athlete, given that these values are individually affected [14].

Nevertheless, while monitoring ANS during a competitive period among female Olympic wrestlers, a reduction of vagal indices was verified, which are associated to non-functional overreaching, thus indicating a state of "early alert" for the state of training/recovery relationship among the athletes evaluated [9]. Additionally, recent studies show that the ANS is very sensitive to load alterations in training [15, 16]. Therefore, ANS is an important regulator of homeostasis during periods of heavy training loads and can be measured by HRV indices, which will indicate states that are associated to non-functional overreaching, as well as overtraining [14, 17]. Furthermore, the ability to maintain the balance for autonomic responses among elite athletes by means of an ideal distribution of training intensity is an important factor to maximize performance [16].

Accordingly, some studies indicate that high-intensity interval training (HIIT) in combat sports can be an efficient method to optimize aerobic/anaerobic performance [18-20]. However, the above-mentioned researches with the use of HIIT, used running to maximize athletic performance, thus, the means employed to improve performance were generic. Judo matches involve actions in high-intensity for the upper and lower limbs, i.e., grip disputes for upper-limbs, movements and throws with lower-limbs (*ashi-waza* sequences) [21]. In addition, a study to evaluate the physiological, metabolic, perceptive, as well as autonomic responses, considering the specificity of the effort: pause ratio of judo matches [21], could help the technical staff to quantify the training load of athletes and promote specific physiological, metabolic and autonomic adjustments.

Furthermore, the HIIT studies in combat sports have not monitored training through the RPE, RPR or the ANS by means of HRV. Additionally, a recent study indicated that acute high intensity interval exercise (HIIE) protocols of different effort: pause ratios resulted in slightly different HRV responses when performed with same limbs [22]. Notwithstanding, after maximal exercise on a cycle ergometer for arm or leg, the HRR is different, i.e., reduction of the parasympathetic indices is higher in arm exercises when compared to the leg [23]. Nonetheless, the responses for HIIT on the ANS, cellular damage markers, hormonal concentrations, performance tests, as well as perceptive and psychometric responses remain unknown in longitudinal studies, in protocols with the same temporal structure for different body segments, as well as for specific judo exercises.

Based on these factors, the present study aim was the effects of 4-weeks of three different modes of HIIT with low-volume on the HRV, as well as perceptual, physiological and psychometric responses in judo athletes. It is believed, as a hypothesis, that the inclusion of low-volume HIIT, twice a week, will not modify the ANS, cellular damage markers, hormone levels or psychometric responses in different training groups.

MATERIAL AND METHODS

This study used an experimental design. The judo athletes were randomized into four groups: 1) lower-body; 2) upper-body; 3) *uchi-komi* and 4) control. The experimental groups performed HIIT twice a week during 4-weeks, complementarily to judo training. The control group only performed the judo training. The athletes were submitted to: **a)** venous blood collection at rest; **b)** measurement of HRV at rest before the beginning of each weekly training session; **c)** utilization of the RPR (before) and RPE (session-RPE) after each HIE-session and **e)** completing the *Daily Analysis of Life Demands in Athletes* (DALDA) questionnaire after the last weekly judo training session and the overtraining questionnaire 24 hours after the last weekly judo training session. The figure 1 shows the experimental design.

Participants

The sample consisted of thirty-five experienced judo athletes [(lower-body: n = 9, 22.3 ± 5.2 years old, 76.9 ± 10.9 kg, 173.5 ± 10.9 cm and 12 ± 7 years of practice experience), (upper-body: n = 9, 23.6 ± 6.7 years old, 84.2 ± 13.4 kg, 174.0 ± 5.7 cm and 15 ± 7 years of practice experience), (*uchi-komi:* n = 9, 23.4 ± 4.2 years old, 78.1 ± 13.4 kg, 175.4 ± 7.3 cm and 12 ± 7 years of practice experience) and (control-group: n = 8, 26.4 ± 7.0 years old, 80.2 ± 10.3 kg, 175.0 ± 7.0 cm and 18 ± 7 years of practice experience)], which are the same groups used in the investigation by Franchini et al. [24]. The athletes were recruited from eight different clubs, which compete within the same sporting federation. Athletes from each judo club were allocated to the different experimental groups. In order to participate in the study, the athletes were required to: (1) have participated in official competitions during the current year; (2) have been training at least four times a week; (3) be between 17 and 35 years old; (4) be competing in a weight category under the heavy weight category; (5) not be in a process of weight loss; (6) not be injured; (7) not be consuming any

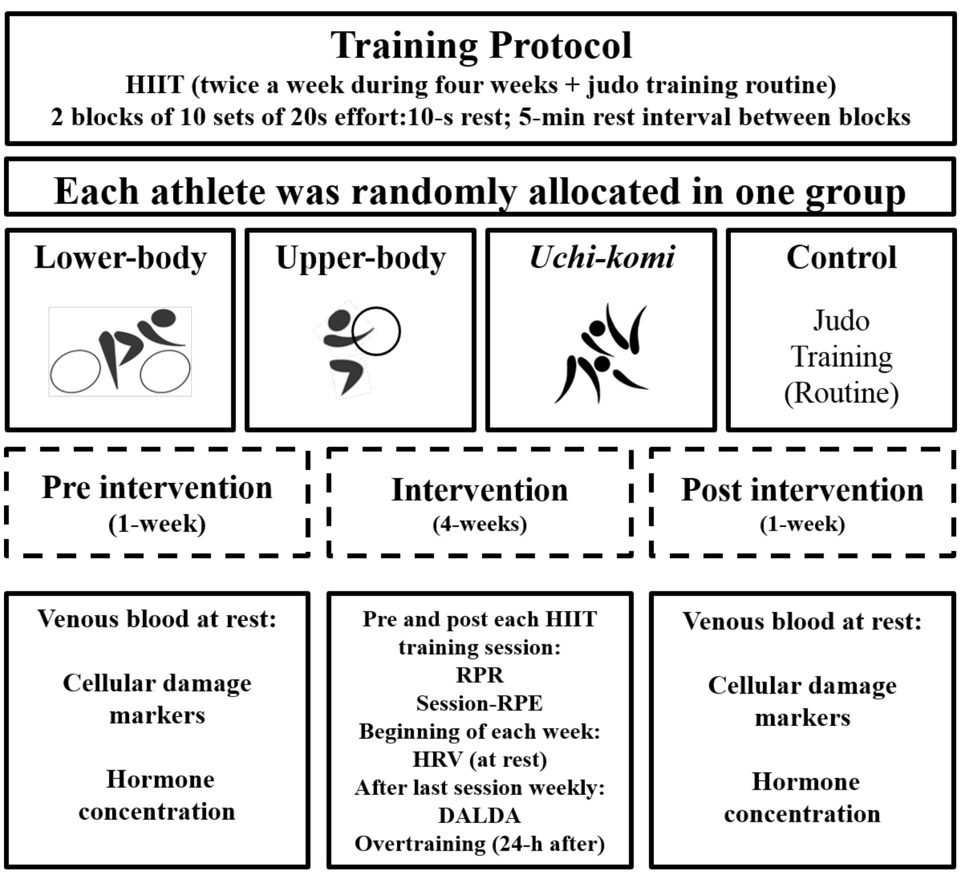

Figure 1. Experimental Design
Note: RPR = rating of perceived recovery; session-RPE: values of the rating of perceived exertion in each high intensity exercise session; HRV = heart rate variability; DALDA and overtraining = questionnaires applied, for more information consult the methods.

type of food supplement or drugs (i.e., anabolic steroids), as well as any medical treatment which could limit or hinder the execution of any activity required by the experimental protocol. The protocol was executed during the competitive period and the athletes were doing four 1h 30min to 2h weekly sessions of judo training. They were also doing three weekly sessions of strength training for the main muscle groups. Strength training was directed to upper- and lower-body muscle power and upper-body strength-endurance. All athletes were submitted to the same judo and auxiliary training sessions, but no detailed control was conducted in these sessions as they were conducted by the judo athletes' coaches. Moreover, athletes were in their competitive period. Thus, the main variation concerning the training performed by the athletes were the HIIT protocols. The present study was conducted in accordance with the International Ethics Directives, as well as the Helsinki Declaration and the local ethics committee, under number 2012/01 of School of Physical Education and Sport of University of São Paulo, approved all experimental procedures.

Training protocols

The athletes of the three experimental groups (lower-body, upper-body and *uchi-komi*) executed two HIIE on alternate days during four weeks as a complement to the typical judo training, while the control group was limited to the usual judo training sessions. Briefly, the groups trained twice a week for 4 weeks, with 2 blocks of 10 x 20s effort, interspersed by 10s passive recovery between sets and 5-min between blocks, added to the judo training sessions. The lower-body and upper-body groups trained on the cycle-ergometer using 4.5% and 3.0% of body mass, respectively. For the *uchi-komi*, athletes performed technique entrance for the set period (20s, with a partner of similar body mass and stature), and executed one throw at the end of each set using an arm or hip technique. A warm-up was conducted for 5-min, interspersed by 3-min of passive recovery. Each session lasted 22min and 40s, counting with 5min warm-up and 3-min of passive recovery. The choice of the referred time structure was due to the following: (1) official judo combats have an average duration of 3-min with high intensity sequences of 20s alternated by 10s between blocks [21]; (2) protocols can be carried out in less than 15-min, including the periods of pause, interspaced with HIIE and (3) in total, the exercise did not exceed 7-min per session, given that there was a slight increase in the total volume of weekly training.

Heart rate variability

The HRV was carried out before the first weekly training session while athletes were at rest and in a standing position (for 5 min), at the same time during the training period and without the breathing rhythm control, while readings were taken [25]. A Polar RS810 heart rate monitor (Polar, Finland) was used to register the HRV and the Kubios HRV software, version 2.2. (Kubios, Finland) was used to conduct the analysis. The measurement of HRV followed the recommendations proposed by the Task Force of The European Society of Cardiology [26]. Time domain calculations were used as from the normal R-R interval averages, the root mean square of successive differences in the R-R intervals (rMSSD), as well as the rMSSD/MRR (mean of R-R intervals) ratio [27]. To simplify the analysis, and to prevent outliers, the rMSSD was transformed into natural log (Ln) [28], given that its coefficient of variation was less than LF/HF, it was decided that rMSSD should be used [29].

Perceived Responses

In order to infer considerations regarding recovery, the RPR was used before each HIIT training session, as developed by Laurent et al. [6]. The RPE (session-RPE) was reported 30min after each HIIT training session, as recommended by Foster et al [30]. In order to quantify the internal training load, the RPE session *versus* the duration of each HIE-session session was used, as described by Foster et al. [30].

Questionnaires

In order to monitor training, the athletes of each group were requested to respond to DALDA [8] and the overtraining questionnaire [7]. It was decided that only the worse than normal (source and stress symptoms – DALDA) and positive responses to the overtraining questionnaire should be considered.

Venous blood sampling and analysis

Venous blood sampling and analyses were taken by means of direct puncture to the antecubital vein (15 mL) at rest and fast, for approximately eight hours. Samples were collected between the 6-7 am (at ~20°) in both moments, in order to eliminate circadian rhythm fluctuations. The blood samples were immediately allocated into two vacutainer type tubes, one containing EDTA for plasma separation and the other, a dry tube for serum separation. Both tubes were centrifuged at 3.500 rpm for 12 min before being stored in tubes at −80°C until the respective analyses. Additionally, all analyses were carried out identically, thus resulting in an inter-experimental variation of less than 5%. The hormonal concentrations of free testosterone (FT) and cortisol (C) were analysed by means of commercial kits (Monobind Inc. 100 North Point Drive, Lake Forest, CA 92630 USA). The cellular damage markers: creatine kinase (CK), lactate dehydrogenase (LDH), aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were analysed by means of commercial kits (Labtest®, São Paulo, Brazil), all the colorimetric assay by ELISA. Furthermore, plasma was used to analyse hormones while serum was used to analyse cellular damage markers. It was decided not to conduct blood collection in the control group because they did not receive the benefits of training and because previous studies indicated that no hormonal or cellular damage marker alterations occur in combat sport control groups during the intervention period [18, 19].

Statistical Analysis

Data is presented by mean and standard deviation (± SD). Previously, an analysis of variance was performed (ANOVA), in order to detect differences between the groups in the first training week, in which the values were no different ($p>0.05$). Thus, an ANOVA *two-way* with repeated measurements was performed, followed by a Bonferroni test, when necessary. When differences were found between the groups during training weeks, an ANOVA *one-way* was carried out in order to detect such differences, followed by a Bonferroni test, as well as a paired *t-test* for

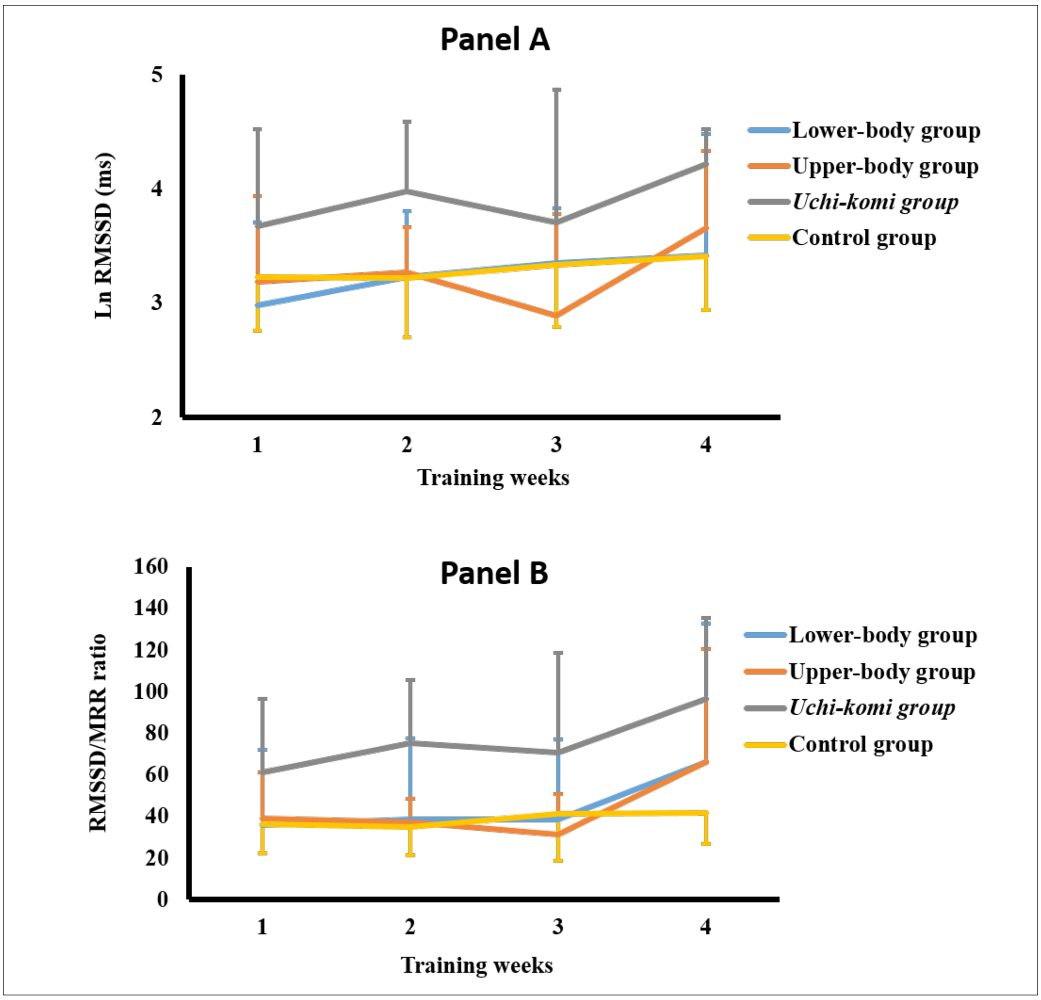

Figure 2. Frequency of heart rate variability at rest, before the first weekly training session during the four weeks of the three different types of high-intensity interval training (data are expressed as mean and standard deviation).

Note: rMSSD = root mean square of successive differences in the R-R intervals; rMSSD/MRR = root mean square of successive differences in the R-R intervals / mean of R-R intervals ratio.

the pre and post-training values. A Mauchly's test of sphericity was used to test this assumption, a Greenhouse-Geisser correction was applied when necessary. The significance level was established at 5%. In order to evaluate the magnitude of differences observed, (*partial eta squared*, ηp^2) was calculated and interpreted according to Cohen [31] with the following values: <0.2 [small], ≥0.2 to <0.8 [moderate] and ≥0.8 [large], for the ANOVA. Furthermore, Cohen´s *d* was calculated as proposed by Rhea [32]. The classification for highly trained athletes was used with the following values: <0.25 [trivial]; 0.25 to <0.5 [small]; 0.5 to <1.00 [moderate] and ≥1.0 [large], for the paired t-tests. All analyses were carried out on Statistica® version 12.0 software (Stasoft, United States of America).

RESULTS

The four experimental groups did not differ as to age, body mass, stature or length of practice in the sport (p>0.05). Figure 2 shows the HRV frequencies of athletes during the four weeks of HIIT.

For Ln rMSSD frequency (panel A), there was no difference for group, training or interaction (p>0.05). For Ln rMSSD/MRR ratio (panel B), there was only a training effect ($F_{3,75}$ = 4.93; p = 0.003; ηp^2 = 0.164, small), with higher values in the fourth week when compared to third (p = 0.005). However, when the Ln rMSSD/MRR ratio was analysed the groups isolated, no difference was found between training for all groups (p>0.05).

Figure 3 shows the RPR of athletes during the four weeks of HIIT. For the RPR, the was only a training effect ($F_{7,168}$ = 2.57; p = 0.015; ηp^2 = 0.097, small) with higher values in the first session when compared to the second (p = 0.004). When the RPR was analysed individually between the groups, there was no difference between training sessions for lower-body and upper-body (p>0.05). However, there was difference between training sessions for the *uchi-komi* ($F_{7,56}$ = 2.96; p = 0.010, ηp^2 = 0.270, moderate), with higher values in the first session when compared to the second (p = 0.014; *d* = −4.4, large).

Figure 4 shows the RPE and internal training load of athletes after each training session during four weeks of HIIT. For the RPE (panel A) and internal training load (panel B), there were no group, training or interaction effects (p>0.05).

Table 1 shows the worse than normal responses of part A and B of DALDA and positive responses to the overtraining questionnaire. For the worse than normal responses to Part A and B of the DALDA, as well as to positive responses to overtraining, there were no group, training or interaction effects (p>0.05).

Table 2 shows the hormonal levels and cellular damage markers at rest condition before and after 4 weeks of the three different modes of HIIT. For the LDH concentration, there was a training effect ($F_{1,23}$ = 6.90; p = 0.015; ηp^2 = 0.231, moderate), with lower values in pre- when compared

Table 1. Worse than normal responses of parts A and B of DALDA and positive responses to the overtraining questionnaire (data expressed as mean and standard deviation).

Questionnaires	Groups	1º week	2º week	3º week	4º week
DALDA: Part A worse than normal	Lower-body	1 ± 1	1 ± 1	1 ± 1	1 ± 1
	Upper-body	1 ± 1	1 ± 2	2 ± 1	1 ± 1
	Uchi-komi	1 ± 2	1 ± 1	1 ± 1	0 ± 1
	Control group	1 ± 1	1 ± 1	2 ± 2	2 ± 1
DALDA: Part B worse than normal	Lower-body	3 ± 2	3 ± 2	2 ± 1	2 ± 1
	Upper-body	4 ± 3	5 ± 2	5 ± 3	5 ± 4
	Uchi-komi	4 ± 3	3 ± 2	3 ± 3	3 ± 3
	Control group	4 ± 4	5 ± 4	4 ± 4	2 ± 2
Positive responses to overtraining	Lower-body	12 ± 6	10 ± 5	8 ± 6	9 ± 5
	Upper-body	9 ± 7	9 ± 5	9 ± 7	11 ± 7
	Uchi-komi	11 ± 7	9 ± 7	8 ± 6	7 ± 6
	Control group	11 ± 6	11 ± 6	12 ± 8	7 ± 4

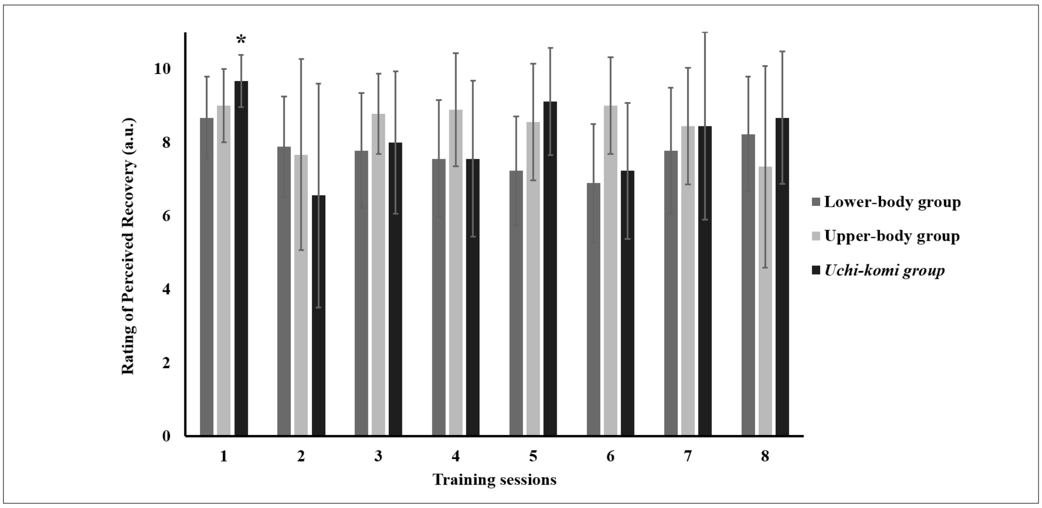

Figure 3. Rating of perceived recovery of athletes during the four weeks of high-intensity interval training.

Note: a.u. arbitrary unit; Data are expressed as mean and standard deviation; *effect of training weeks for the u*chi-komi* group, with higher values for first session when compared to second (p = 0.014)

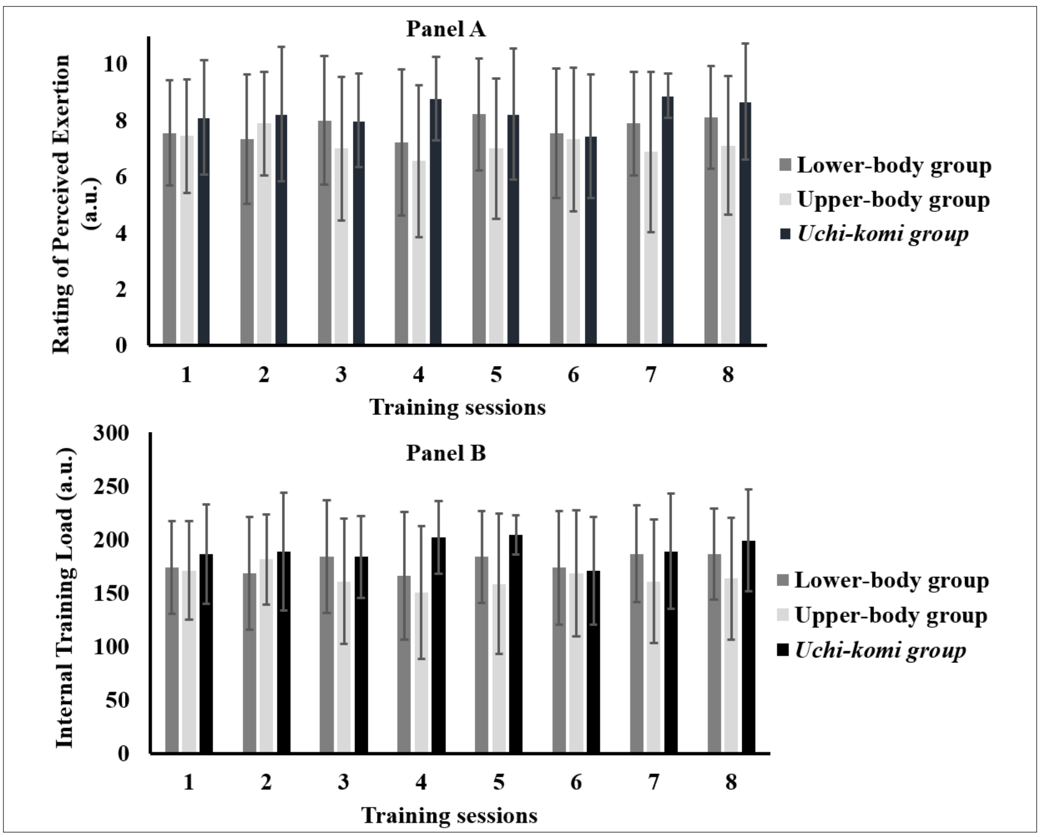

Figure 4. Rating of perceived exertion and internal training load of athletes during the four weeks of high-intensity interval training.

Note: Panel A = rating of perceived exertion; Panel B = internal training load; data are expressed as mean and standarddeviation; a.u. = arbitrary unit.

to post-training (p = 0.015) and an interaction ($F_{2,23}$ = 3.87; p = 0.035; ηp^2 = 0.252, moderate), with lower values for upper-body in pre- when compared to post-training (p = 0.025). Nevertheless, the t-test only showed differences for the upper-body group (t_9 = −2.60; p = 0.031; *d* = 1.75, large), with higher values in post- when compared to pre-training. For the AST, ALT, CK, FT, C and free-testosterone/cortisol ratio (T/C) concentrations, no group, training or interaction effects were found (p>0.05).

DISCUSSION

The most relevant results were: **1)** no differences for all HRV indices, absence of differences for psychometric responses, for RPE and internal training load; **2)** decrease of RPR in second HIE-session, when compared to first for *uchi-komi* group; **3)** absence of differences for all experimental groups to CK, AST, ALT, FT, C and T/C concentrations **4)** increase of LDH for the upper-body group after 4-weeks. Therefore, the hypothesis that the inclusion of low-volume HIIT, twice a week, would not modify the ANS, cellular damage markers, hormone levels or psychometric responses in different training groups, was partially confirmed.

The measurement of HRV has proved to be an effective tool for prescription and control of internal training load [14]. Recent reviews indicated that rMSSD is highly sensitive in detecting changes to training load and symptoms associated to functional and non-functional overreaching, as well as overtraining [9, 11, 33]. Furthermore, the rMSSD shows lower sensitivity to breathing patterns when compared to spectral variables, causing less fluctuation in their values [34]. Similarly, the relationship between the rMSSD/MRR can be an important index for the reading of training status in top athletes, and to indicate a saturation phenomenon [11, 28]. According to these authors [11, 28] his phenomenon refers to a decrease in vagal-related HRV indices associated to low HR values, and is a response to an increased vagal activity. The underlying mechanism is the likely saturation of acetylcholine receptors at myocite level. Thus, a heightened vagal tone probably rise the sustained parasympathetic control of the sinus node, which may eliminate respiratory heart modulation and decrease vagal-related HRV indexes. Therefore, it is important that coaches perform the HRV control measures during all phases of the athlete's periodization, as each athlete can present different responses to ANS [14]. However, the HRV responses to HIIT protocols in the same temporal structure in longitudinal studies of different body segments are still unknown.

As such, although HRR shows different responses to the ANS after maximal acute exercise on different body segments, in which the parasympathetic activity seems to be more pronounced in the arm exercise when compared to the leg [22], are responses which were not confirmed in the present study. Furthermore, Cipryan et al. [22] found that the exercises performed at high-intensity were the same by volume and effort: pause ratio (1:1), but not by effort time, i.e., 15/15s, 30/30s and 60/60s, thus showing a better recovery of

Table 2. The hormonal concentrations and cellular damage markers at rest before and after 4 weeks of three different modes of high-intensity interval training.

Indicator	Lower-body (n = 9)		Upper-body (n = 9)		*Uchi-komi* (n = 9)	
	pre	post	pre	post	pre	post
CK (U.L^{-1})	460.7 ± 569.7	773.3 ± 1096.4	317.1 ± 324.2	105.3 ± 44.5	436.6 ± 481.0	205.6 ± 171.6
LDH (U.L^{-1})	60.6 ± 25.2	57.0 ± 19.4	57.9 ± 19.1	91.5 ± 44.0*	70.4 ± 23.2	84.2 ± 23.2
AST (U.L^{-1})	4.4 ± 2.0	5.9 ± 3.8	4.1 ± 2.1	4.5 ± 1.4	5.3 ± 1.5	5.1 ± 1.8
ALT (U.L^{-1})	2.96 ± 1.06	3.65 ± 1.05	3.78 ± 1.59	3.73 ± 1.82	3.92 ± 1.20	3.65 ± 1.18
C (ng.mL^{-1})	17.42 ± 4.03	18.32 ± 2.83	13.35 ± 5.22	13.36 ± 5.87	16.45 ± 3.11	15.20 ± 5.94
T (ng.mL^{-1})	4.77 ± 1.27	5.15 ± 0.22	4.65 ± 1.56	5.11 ± 0.20	5.23 ± 0.12	5.17 ± 0.16
T/C ratio	0.30 ± 0.12	0.29 ± 0.06	0.42 ± 0.23	0.66 ± 0.90	0.33 ± 0.08	0.42 ± 0.24

Note: Data expressed as mean and standard deviation; CK = creatine kinase; LDH = lactate dehydrogenase; AST = aspartate transaminase; ALT = alanine transaminase; C = cortisol; T = free-testosterone; T/C = free-testosterone / cortisol ratio; *training period effect, with lower values in pre-training when compared to post-training (p = 0.031).

the ANS in the 30/30s ratio. However, unlike the Cipryan et al. [22], the same effort: pause ratio was used, but in different body segments of participating athletes. Accordingly, the responses of ANS in the present study indicate a chronic adaptation to HIE, although the judo training, to which the athletes are accustomed, was done intermittently at high-intensity [5].

In contrast, Morales et al. [10] compared the responses of the ANS before and after four weeks of judo training. Using two groups: high training load (HTL) and moderate training load (MTL). The HRV indices, maximum strength and general/specific recovery decreased in the HTL group, while the values remained stable in the MTL group. The lower vagal indices in the aforementioned study, could be the result of inadequate recovery of the HLT group, thus causing a delay of parasympathetic activity [35]. These responses were different to those of the present study. The reason for such findings is that the protocol adopted in the present study had a low weekly volume, increasing about 15-min of effective training per week, whereas Morales et al. [10] accumulated additional volume. Therefore, changes in the vagal indices seem to be linked to duration of exposure to exercise and not just the intensity.

The decrease in RPR in the *uchi-komi* group could be related to technique entrance overload, which involves displacing and projecting the partner, unlike the other exercises that are single-joint movements. On the other hand, this decrease was found only in the second session, indicating rapid adjustment in RPR for the *uchi-komi* group in subsequent training sessions. The absence of differences in RPE and internal training load during training period, suggest that HIE-sessions were similar in all experimental groups. There were no modifications for both questionnaires (DALDA and overtraining) during the four weeks of HIIT, in accordance with Farzad et al. [19] who did not detect any overtraining symptoms after the inclusion of HIIT in wrestling athletes. This confirms that HIIT (with extra low volume) does not cause conditions associated to non-functional overreaching and overtraining symptoms.

Additionally, no modifications of FT, C and T/C ratio were found, in agreement with Farzad et al. [19]. Furthermore, an increase of total testosterone concentration was observed after 4-weeks of HIIT in the Farzad et al. [19] which may be considered as a positive response, because total testosterone is an anabolic hormone. In fact, the increases of LDH and CK concentration are related to strenuous exercise, as in HIE [36]. Cellular damage occurs when there is an extravasation of substances in the sarcolemma, identifiable via serum measurement. The increase in LDH concentration in the upper-body group could be associated with an additive effect and residual fatigue, given that the actions of the upper limbs are predominant in judo combat [37]. Added to the HIE for the upper-body, this could potentialise the cellular damage of said group. It becomes relevant that the joint analysis of the cellular damage markers (CK, LDH, AST and ALT), avoids misinterpretations [4].

A series of markers were used to detect the risks associated with overtraining, however, it was noted that none met all the acceptance criteria [1]. Therefore, it is important to point out that such measures be carried out jointly: HRV, blood measures, RPE, RPR, and psychometric questionnaires must be used for optimal training monitoring [11].

CONCLUSIONS

Based on the results, it was concluded that low volume HIIT, does not promote changes in ANS, as well as, psychometric tests and hormone responses for the three experimental groups. However, there is an increase of LDH concentrations in the upper-body group after 4-weeks, which can be attributed to the additive effect. Finally, it is worth mentioning that the training should be constantly monitored by means of HRV, perceptive scales, internal training load, and psychometric questionnaires in order to avoid accumulated fatigue, maximize athletic performance and avoid injuries.

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EDITORIAL NOTE

The main educational mission of the Editorial Board of each scientific journal is to take care of the highest methodological standards. Regardless of a scientific profile of any journal, the common element is to respect the canons of logic and general methodology of studies. Any interference in the content of the article with respect to these two aspects is an editorial responsibility and results from care of the scientific publication quality.

As far as specialist journals are concerned, the attention is paid to the clarity of technical terminology. This is the responsibility of the editors and competent reviewers. Lack of terminological unity in many specific disciplines and scientific specialties derives mainly from the *Iron Curtain* which was symbolically ended by a demolition of *the Berlin Wall* [41]. Glossaries presented to authors for approval are a universal mean of seeking specific educational compromise.

Editorial practice which tolerates not only the scientific jargon is an enemy of the so-defined standards of methodological correctness. Keeping up with a fashion which cannot be considered as a jargon poses an equally significant threat to methodological correctness (which is the core of science). This is an overt absurdity.

The Editorial Board of *Archives of Budo* experiences this phenomenon in a peculiar manner. There is a group of authors who previously approved any editorial changes in their articles (which are in line with the standards defined above). In the subsequent articles, they continue to insist on the following wording of the objective of a scientific publication: "*the aim of this study is investigation...*"; "*the purpose of this work is determination...*", etc.

Teleology is a specific science which focuses on the aims. The "aim" is an elementary category of methodology of sciences and praxeology and was assigned by Tadeusz Kotarbiński [42] a "proper" methodological value.

Since "the objective is an item or a state of affairs", any action (actions) to achieve it is a mean of action (i.e. an indirect goal). Scientific studies (theoretical or empirical ones) are always about a particular cognitive objective. This is at the same time a primary objective of any scientific study. Knowledge about given phenomenon is their final objective. Science produces justified theorems and theories [43]. The primary objective of a scientific publication (even if it is limited to a description of an innovative method, research procedure, etc.) is to obtain certain new knowledge or to lend credence to knowledge about a given phenomenon (or to refute it).

The main means used include certain *investigations*, *observations*, necessary *analyses*, *etc.* Specific measures include measurements, marker assays, computations, mathematic calculations, etc. For example, the main goal of investigation for a professional laboratory technician (who is not necessarily a co-author of the publication) is to carry out measurements precisely. On the other hand, the principal investigator (and potentially the main author of the publication) considers the investigation carried out by a laboratory technician as a specific task. It is the principal investigator who should split the objective into tasks and who should be aware that these tasks become primary objectives for particular persons or teamsw (but not for him/her). If the principal investigator performs these tasks in person, their nature does not change. They continue to be means implemented to achieve the primary cognitive goal (indirect objectives). Under certain circumstances, these are means of achieving other intermediate goals and the primary objective, i.e. knowledge, only after necessary analyses.

Ashi-waza – leg techniques (sub classification: *deashi-barai; kouchi-gari; okuri-ashi-barai; osoto-gari; osoto-otoshi; sasae-tsurikomi-ashi; uchi-mata).*

Uchi-komi (uchikomi) – repetition of basic technique in kendo and judo training [44].

Training periodization – depending of the phase of periodization plan, the training emphasis will shift to develop specific characteristics and manage fatigue. A truly comprehensive plan includes dietary recommendation and psychological training. If the training plan is not completely integrated, the likehood that the athlete will achieve successful results is significantly decreased. The annual training should contain at least preparatory, competitive, and transition phases [45, p. 146].

Training load – "A simple mathematical model of training load can be defined as the product of qualitative and quantitative factor. This reasoning may became unclear whenever the quantitative factor is called 'workload volume' or 'training volume' interchangeably with 'volume of physical activity'. Various units have been adopted as measures i.e. the number of repetitions, kilometres, tons, kilocalories, etc. as well as various units of time (seconds, minutes, hours) (...) As in the real world nothing happens beyond the time, the basic procedure of improvement of workload measurement should logically start with separation of the time factor from the set of phenomena so far classified together as '***workload volume***'. (...) Due to the fact that the heart rate (HR) is commonly accepted as the universal measure of workload intensity, the product of effort duration and HR seems to be the general indicator of ***training load*** defined as the amount of workload. It is useful in analyses with a high level of generality. (...) In current research and training practice the product of effort duration and HR was referred to as conventional units' or further calculations have been made to convert it into points." [46, p. 238].

Therefore, the "*the aim of this study is a knowledge about* (and further providing a name of given phenomenon or phenomena as accurate as possible)" is a proof of the methodological competence of authors (in a sense of editing a scientific research article).

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