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High load inspiratory muscle warm-up has no impact on Special Judo Fitness Test performance

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Key words: judo, inspiratory warm-up, respiratory muscles, sport performance

Abstract

Background. Respiratory muscles may play an important role in combat sports such as judo in order to meet the high ventilatory demand and to contribute to postural control.

Problem and aim. To determine the influence of inspiratory muscle exercise (IMW) as specific respiratory muscle warm-up in a randomized controlled cross-over trial.

Methods. 11 judo athletes were assigned to three different warm-up protocols and the effects of IMW on Special Judo Fitness Test (SJFT) were assessed. Each judoka completed three different IMW protocols: *uchi-komi* warm up (control); warm-up plus IMW (2 sets of 15 breaths with a 60% maximum inspiratory mouth pressure load); *uchi-komi* warm-up plus sham IMW warm-up (2 sets of 15 breaths with a 15% maximum inspiratory mouth pressure load). The SJFT performance was assessed following each type of warm-up protocol as well as heart rate (HR) and the rate of perceived exertion (RPE).

Results. There was no effect of the warm-up protocol on total number of throws ($p = 0.141$), HR after the test ($p = 0.676$), HR 1 min after the test ($p = 0.543$) and performance index ($p = 0.240$) of the SJFT. However, RPE differed between conditions ($p = 0.037$), post-hoc Bonferroni tests indicating only a tendency for higher values in the high load IMW condition compared to the control ($p = 0.061$) and placebo ($p = 0.095$) conditions.

Conclusion. High load IMW did not improve SJFT performance in elite judokas.

Introduction

The main purpose of the respiratory system is to perform gas exchange, allowing oxygen (O_2) to pass from atmospheric air to the blood and carbon dioxide (CO_2) to be eliminated from the body [West 2012]. Its mechanical functioning depends on the ability of the respiratory muscles to contract during inspiration and expiration [Dempsey *et al.* 2006; West 2012]. Respiratory muscles can fatigue during exercise [Verges *et al.* 2006, 2007] and respiratory muscle fatigue can impair exercise performance through several mechanisms such as increased dyspnea and enhanced peripheral muscle fatigue [Dempsey *et al.* 2006].

In high-level sport, it has been sought to determine strategies to optimize respiratory muscle function and to prevent respiratory muscle fatigue [HajGhanbari *et al.* 2012]. Inspiratory muscle warm-up (IMW) is a strategy for this purpose, which may increase respiratory muscle functional capacity and decrease exercise-induced respiratory muscle fatigue [Volianitis *et al.* 2001]. IMW has been shown to be an efficient method to improve rowing 6-min maximal performance [Volianitis *et al.* 2001], swimming 100-m performance [Wilson *et al.* 2014], running performance [Tong and Fu, 2006], respiratory sensations and performance in badminton players [Lin *et al.* 2007]. The increase in inspiratory muscle strength result in optimization of muscle contractile function and elicit an elevated ventilatory response that may prepare the respiratory muscles for the high exercise demands [Ozdal 2016]. Possible mechanisms are the cooperation of the upper thorax, neck, and other accessory respiratory muscles allowing an increased respiratory efficiency and providing a more pronounced effect of blood flow elevation, as well as a reflex inhibition of motor neurons resulting in greater force generation [Volianitis *et al.* 2001; Ozdal 2016]. Moreover, the improvement of muscle O_2 delivery-to-utilization increases O_2 availability, which is a key element to enhance the oxidative energy release [Cheng *et al.* 2013; Ozdal 2016].

However the effects of IMW on sports performance enhancement remain controversial, especially regarding high-intensity exercise performance: one study demonstrated IMW-induced enhancement in anaerobic power performance in hockey players [Ozdal *et al.* 2016]. Meanwhile another study focusing on high-intensity intermittent cycling (6 × 10s with 60-s recovery intervals) did not demonstrate any improvement in exercise capacity following IMW [Ohya, Hagiwara, Suzuki 2015]. It is important to note that all previous IMW protocols (sports gestures associated or not) were performed with a 40% maximal inspiratory pressure (MIP) load [Volianitis *et al.* 2001; Wilson *et al.* 2014; Ohya, Hagiwara, Suzuki 2015]. More intense protocols, associated with sport-specific gestures, require further investigation to evaluate their impact on athletic performance [Arend, Kivastik, Mäestu 2016]. Although it has not been widely studied in aerobic performance [Verges *et al.* 2007; HajGhanbari *et al.* 2012], optimizing the respiratory function can play a crucial role in combat sports such as wrestling and judo, not only for its role in regulating the acid-base balance, but also in helping to distribute energy to all muscle groups [Tocilj, Erceg, Karnincic 2015]. Moreover, the intra-abdominal pressure and the strength of the respiratory muscles are closely related to the behavior of breathing during the Valsalva maneuver associated with weightlifting in highly trained judo athletes, including a coupling between respiratory muscle and peripheral force production [Kawabata *et al.* 2010]. Therefore, the respiratory muscles could play a critical role in judo performance because of their major involvement in posture [Cavaggioni *et al.* 2015; Barbado *et al.* 2016; Tukel *et al.* 2017]. However, no study was found investigating the effects of IMW in combat sports specific performance.

In judo, specifically, the Special Judo Fitness Test has been used to assess performance in a sport-specific, but in a more controlled setting [Sterkowicz-Przybycien *et al.* 2017]. This test has been reported to be reliable [Sterkowicz 1995], valid and predominantly anaerobic [Franchini *et al.* 2011], to be perceived as resulting a similar effort as that experienced during an official judo match [Franchini *et al.* 1998], to properly discriminate elite and non-elite judo athletes [Franchini *et al.* 2005], and to be related to both aerobic and anaerobic physiological indexes [Detanico *et al.* 2012; Sterkowicz-Przybycien *et al.* 2017]. Consequently, classificatory tables were developed for this test [Agostinho *et al.* 2018; Franchini *et al.* 2009; Sterkowicz-Przybycien, Fukuda 2014], and its application has been extensively used worldwide [Sterkowicz-Przybycien *et al.* 2017]. Despite this, only two studies investigating the effects of warm-up procedures on the SJFT performance were found [Miarka *et al.* 2011; Lum 2017]. Miarka *et al.* [2011] reported that a plyometric exercise used during the warm-up resulted in higher number of throws during the series A of the SJFT compared to a control condition, whereas contrast exercise resulted in lower index (i.e. a better result) compared to the plyometric warm-up and to the control condition. Lum *et al.* [2017] reported that the number of throws in series A of the SJFT was higher after both lower- and upper-body warm-up procedures compared to the control condition, whereas only the upper-body warm-up resulted in higher total number of throws compared to the control condition. Thus, the use of warm-up procedures focusing on neuromuscular aspects have been useful to improve the SJFT performance. However, no study was conducting examining the effect of other type of warm-up on the SJFT performance.

Therefore, the objective of this study was to assess the effect of specific IMW in judo athletes. The main hypothesis of the present study was that specific judo performance measured by the SJFT would be improved following a high intensity inspiratory warm up by optimizing respiratory muscle function before exercise.

Materials and methods

Experimental trial setup

To assess the effect of the inspiratory muscle warm-up, an investigation with three different experimental protocols was planned. This study was a randomized controlled cross-over trial. Before data collection, the subjects were familiarized with all measures, such as manovacuometry and spirometry, and performed pulmonary function tests and the incremental cardiopulmonary test in the Exercise Lab. On a second visit, which was held in the *dojo*, three warm-up protocols were done: control (two sets of fifteen *uchi komi* drills), IMW and placebo IMW (Figure 1). Following each warm-up protocol, a specific judo test (SFJT, see below) was performed. All subjects performed the three warm-up conditions in a randomized order, with 30 min of rest in between.

IMW and placebo IMW were performed during *uchi-komi* drills [Franchini, Panissa, Julio 2013], with one breath immediately after each movement, i.e. 30 breaths in total [Arend, Kivastik, Maestu 2016]. IMW was performed using a POWERbreathe® inspiratory loading valve (IMT Technologies Ltd.) at 60% of MIP [Arend, Kivastik, Maestu 2016] measured before the start of the protocol [Volianitis *et al.* 2001; Wilson *et al.* 2014; Arend, Kivastik, Maestu 2016]. Participants were instructed to initiate each breath from the residual volume. Placebo IMW was performed using the same procedure but the intensity was 15% of MIP [Cheng *et al.* 2013].

Participants

A sample size calculation was conducted using the variable maximal inspiratory pressure as the main outcome, considering previous studies [Arend *et al.* 2015; Arend, Kivastik, Maestu 2016]. This calculation indicated that six subjects were necessary in this crossover design (with three conditions). An effect size ($f = 0.55$), the probability of a type I error was set at 5%, and probability of a type II error was set 20%. Considering the possibility of dropouts during the study, 11 male national team judo athletes from different weight categories (60 kg = 2; 66 kg = 3; 73kg = 2; 81 kg = 1; 100 kg = 2; over 100 kg = 1) were selected and voluntarily took part in the present study. Baseline characteristics of subjects are given in table 1, whereas performance and physiological responses to the maximal graded exercise test are presented in table 2. Athletes recovering from injury or with injury linked to the sport or disabled from the ideal judo practice were excluded. Athletes participated in the study only after giving written informed consent. The local ethics committee approved all procedures (Nº: 1.881.537). The study was conducted in adherence to the Declaration of Helsinki [World Medical Association, 2013].

Procedures

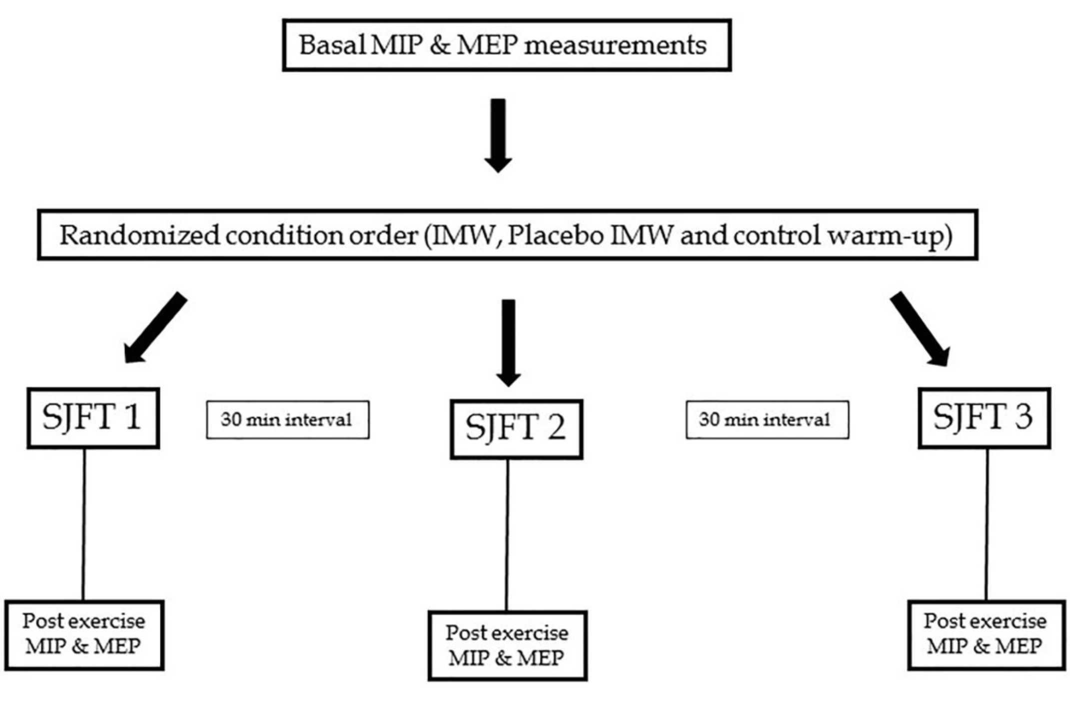
Lung function

Pulmonary function was evaluated using a spirometer (Vmax Encore System®, CareFusion, Yorba Linda, USA), which was calibrated before each test session using a 3L calibration syringe (Vmax Encore System®, CareFusion, Yorba Linda, USA). After familiarization, the three best maneuvers for forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV_1) were recorded [Miller *et al.* 2005].

Respiratory muscle strength

Maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) were measured in a sitting position with a pressure transducer (MVD-300®, Globalmed, Porto Alegre, Brazil). At least five measurements were

Figure 1. Judo IMW study experimental design (SJFT: Special Judo Fitness Test; MIP: maximal ispiratory pressure; MEP: Maximal espiratory pressure; IMW: inspiratory muscle warm-up)



performed and the highest values (peak values) were recorded with a difference lower than 10% between the two highest values [ATS/ERS Statement on respiratory muscle testing, 2002]. Measurements were presented in absolute (cmH_2O) and percentage of predicted value. All maneuvers were performed with verbal encouragement to ensure individuals performed maximum effort. After each SJFT protocol, MIP and MEP were measured to evaluate the effect of respiratory warm up on inspiratory and expiratory strength.

Maximal aerobic power

A maximum incremental cycling test was performed to determine the maximum oxygen consumption (VO_{2peak}). After 5 min of warm-up at 75W, the power was increased by 30W every 2 minutes until exhaustion. The subject was required to maintain a cadence of 75 rpm during the whole test [Ohya, Hagiwara, Suzuki 2015]. The test ended when the subject could no longer maintain the cadence required despite vigorous encouragement. The test was performed on a cycle ergometer (Corival®, Lode, Groningen, the Netherlands) using a breath-by-breath metabolic cart (Vmax Encore System®, CareFusion, Yorba Linda, USA). Dyspnoea and lower limb fatigue were obtained every 2 minutes during exercise [ATS/ACCP Statement on cardiopulmonary exercise testing, 2003]. Maximum voluntary ventilation (MVV) was estimated as 37.5 x FEV_1 [ATS/ACCP Statement on cardiopulmonary exercise testing, 2003].

Special Judo Fitness Test

The Special Judo Fitness Test (SJFT) is a specific evaluation test divided into three periods of effort: (A = 15s, B and C = 30s each), with 10s of the interval between them. Two *ukes* (thrown colleagues) were positioned 6m away and *tori* (participant) ran for each *uke* and threw them as many times as possible using the *ippon-seoi nage* technique. All athletes involved had similar height and body mass [Franchini *et al.* 1998]. Heart rate (HR) was measured using Polar® frequency meter (Model FT1 C, Vantaa, Finland) immediately at the end and 1 min after the test. The data were placed in the index below [Franchini *et al.* 1998]:

$$\text{Index} = \frac{\text{Final HR (bpm)} + \text{HR at 1 min after the test (bpm)}}{\text{Number of throws}}$$

The higher the value of the index is, the worse is the performance in the SJFT [Franchini, Del Vecchio, Sterkowicz 2009].

Rate of perceived exertion (RPE)

A modified Borg scale [Borg 1982] was used to assess the global feeling of the exercise intensity, i.e. how do the subjects perceived the intensity of the effort, before and after each SJFT protocol. The scale is composed of a series of integers from 0 to 10.

Table 1. Athletes' baseline characteristics.

Variables	Athletes (n = 11)
Age (years)	22.3 ± 2.3 (21.0 to 23.6)
Body mass (kg)	83.6 ± 24.9 (71.8 to 99.2)
Height (cm)	176.9 ± 8.7 (172.2 to 182.1)
Lung Function	
FEV_1 (L) and [%pred]	4.3 ± 0.78 [92 ± 7] (3.9 to 4.8)
FVC (L) and [%pred]	4.9 ± 1.00 [93 ± 7] (4.4 to 5.6)
FEV_1/FVC (%)	89 ± 5 (86 to 92)
Respiratory Muscle Strength	
MIP (cmH_2O) and [%pred]	167 ± 37 [116 ± 20] (147 to 190)
MEP (cmH_2O) and [%pred]	141 ± 13 [95 ± 8] (133 to 149)

Data are presented as mean ± standard deviation, 95%CI: 95% confidence interval are presented between parenthesis; FEV1: forced expiratory volume in one second;%pred:% predicted; FVC: forced vital capacity; MIP: maximal inspiratory pressure; MEP: maximal expiratory pressure.

Table 2. Measurements during the incremental cardiopulmonary exercise testing.

Variables	Athletes (n = 11)
Peak exercise	
$\dot{V}O_2$ (mL/min)	3409 ± 812 (3007 to 3095)
$\dot{V}O_2$ (mL/kg/min)	41.9 ± 8.1 (37.1 to 46.6)
$\dot{V}CO_2$(mL/min)	3572 ± 829 (3130 to 4108)
$\dot{V}E$ (L/min)	131.9 ± 31.1 (116.3 to 150.3)
VT (L)	2.8 ± 0.7 (2.4 to 3.1)
f (breaths/min)	47 ± 7 (43.6 to 53.0)
$\dot{V}E$/MVV	0.8 ± 0.3 (0.7 to 1.0)
HR (beats/min)	175 ± 10 (169 to 180)
O_2 pulse (mL/beats)	19.1 ± 4.8 (16.5 to 22.0)
Peak workload (W)	232 ± 45 (208 to 261)
Borg dyspnoea (a.u.)	4 ± 2 (2 to 5)
Borg leg effort (a.u.)	9 ± 1 (9 to 10)
Anaerobic threshold	
$\dot{V}O_2$ (mL/min)	2566 ± 516 (2304 to 2901)
HR (beats/min)	150 ± 9 (145 to 154)

Data are presented as mean ± standard deviation; 95%CI: 95% confidence interval are presented between parenthesis; $\dot{V}O_2$: oxygen uptake; $\dot{V}CO_2$: carbon dioxide output; $\dot{V}E$: minute ventilation; VT: tidal volume; *f* = breathing frequency; MVV: maximum voluntary ventilation; HR: heart rate; O_2 pulse: oxygen pulse; a.u. = arbitrary units

Statistical analysis

The data are presented as mean and standard deviation, and 95% confidence intervals. The normality of distribution and homogeneity of variances of the main variables were confirmed using a Skewness-Kurtosis normality test and the Levene's test, respectively. To evaluate the differences between the three warm-up protocols and between MIP and MEP values after SJFTs, one-way ANOVAs with repeated measures were used. Post hoc Bonferroni tests were applied to determine a difference between two mean values if the ANOVA revealed a significant main effect or interaction effect. Partial eta squared (η^2) was also calculated to determine the effect size, with the 0.0099, 0.0588, and 0.1379 effect sizes considered as small, medium, and large, respectively [Cohen 1988]. The parametric tests were conducted after finding normality and sphericity of the data. Values of $p < 0.05$ considered statistically significant. The probability of a type I error was set at 5%. Data were analyzed using STATISTICA® 13.2 software; (Round Rock, TX, USA).

Results

Table 3 presents the performance, maximal inspiratory and expiratory pressure and RPE for each SJFT in the different experimental conditions. There was no effect of experimental condition for number of throws in A ($F_{2,20} = 1.46$, $p = 0.256$, $\eta^2 = 0.127$, medium), B ($F_{2,20} = 2.77$, $p = 0.086$, $\eta^2 = 0.217$, large) and C ($F_{2,20} = 0.91$, $p = 0.420$, $\eta^2 = 0.083$, medium), for total number of throws ($F_{2,20} = 2.16$, $p = 0.141$, $\eta^2 = 0.178$, large). Likewise there was no effect of experimental condition of HR after the test ($F_{2,20} = 0.400$, $p = 0.676$, $\eta^2 = 0.039$, small), HR 1 min after the test ($F_{2,20} = 0.63$, $p = 0.543$, $\eta^2 = 0.059$, medium) and SJFT Index ($F_{2,20} = 1.54$, $p = 0.240$, $\eta^2 = 0.133$, medium). RPE differed between conditions ($F_{2,20} = 3.91$, $p = 0.037$, $\eta^2 = 0.281$, large), although the Bonferroni test indicated only a tendency for higher values in the IMW condition compared to the control ($p = 0.061$) and placebo IMW ($p = 0.095$) conditions. There was no effect of condition for MIP post exercise ($F_{3,30} = 1.48$, $p = 0.241$, $\eta^2 = 0.129$, medium) or MEP post exercise ($F_{3,30} = 1.07$, $p = 0.378$, $\eta^2 = 0.096$, medium).

Discussion

The main results of the present study did not confirm our hypothesis and suggest that there was no impact of IMW on SJFT performance in elite judo athletes. In addition, the subjects reported larger RPE in the IMW condition. Several studies have shown sports performance enhancement with an IMW consisting of two sets of 30 breaths at 40% of MIP which resulted in improved MIP [Volianitis *et al.* 2001; Tong, Fu 2006; Lin *et al.* 2007; Wilson *et al.* 2014]. However, other studies with similar protocol did not demonstrate performance improvement [Johnson *et al.* 2014; Arend *et al.* 2015; Ohya, Hagiwara, Suzuki 2015;

Table 3. Performance, maximal inspiratory and expiratory pressures and rating of perceived exertion during the Special Judo Fitness Test in the different experimental conditions.

Variables	Control (n = 11)	IMW (n = 11)	Placebo IMW (n = 11)	ANOVA p value
SJFT index	11.00 ± 1.50 (10.22 to 11.93)	10.44 ± 1.39 (9.62 to 11.20)	11.00 ± 1.64 (10.18 to 12.00)	0.240
Number of throws A 15s	6 ± 1 (6 to 7)	6 ± 1 (6 to 7)	6 ± 1 (6 to 7)	0.256
Number of throws B 30s	11 ± 1 (11 to 12)	12 ±1 (11 to 13)	11 ± 1 (11 to 12)	0.086
Number of throws C 30s	11 ± 1 (10 to 12)	11 ± 1 (10 to 12)	11 ± 1 (10 to 12)	0.420
Total number of throws	28 ± 3 (27 to 30)	30 ± 3 (28 to 32)	29 ± 3 (27 to 31)	0.141
HR immediately after the test (beats/min)	178 ± 13 (171 to 187)	177 ± 12 (171 to 186)	180 ± 10 (175 to 186)	0.676
HR 1 min after the test (beats/min)	135 ± 16 (126 to 145)	132 ± 20 (120 to 145)	137 ± 18 (126 to 147)	0.543
MIPpost SJFT (cmH_2O)	177 ± 28 (160 to 193)	175 ± 26 (160 to 190)	160 ± 36 (139 to 179)	0.241
MEPpost SJFT(cmH_2O)	142 ± 15 (133 to 150)	131 ± 21 (120 to 143)	136 ± 30 (120 to 154)	0.378
RPE (a.u.)	6 ± 2 (4 to 7)	7 ± 1 (6 to 8)	6 ± 1 (5 to 6)	0.037*

Data are presented as mean ± standard deviation; 95%CI: 95% confidence interval are presented between parenthesis; SJFT: Special Judo Fitness Test; HR: Heart rate; MIP: maximal inspiratory pressure; MEP: maximal expiratory pressure; RPE: rating of perceived exertion; a.u. = arbitrary unit; IMW: inspiratory muscle warm-up.

Faghy, Brown 2017]. The present study IMW consisted of two sets of 15 breaths at 60% of MIP, a high resistive load, with the hypothesis that high-intensity IMW would bring larger benefit [Arend *et al.* 2015; Arend, Kivastik, Maestu 2016]. This sudden loading of the IMW might improve the intra and inter-muscular coordination by removing reflex inhibition in inspiratory muscles and decreasing the degree of co-contraction between inspiratory and expiratory muscles, respectively, resulting in greater force generation [Volianitis *et al.* 2001]. However, this was not confirmed by our results.

Given the importance of psychophysiological assessments reported in response to combat sports training and competition [Slimani *et al.* 2017], the relevant findings in our results suggest that participants might have perceived larger rate of exertion with IMW. This may be a consequence of the high inspiratory resistive load used, which may have resulted in an increased glycolytic contribution. As higher blood lactate – indicative of an increased glycolytic contribution – has been reported to be correlated with RPE [Serrano *et al.* 2001], this can explain the higher RPE in the IMW.

In contrast with previous studies [Volianitis *et al.* 2001; Johnson *et al.* 2014], our data did not demonstrate a post-activation effect in inspiratory muscle strength following IMW. This may be due by some degree of respiratory discomfort, induced by the 60% MIP load [Yanos *et al.* 1990; McConnell, Griffiths 2010]. On the other hand, the type of exercise included in the SJFT may also have influenced the outcomes of the present study since some results suggest that high-intensity intermittent exercise may not generate respiratory muscle fatigue [Minahan *et al.* 2014]. Therefore, the respiratory discomfort perceived by the athletes added to the type of exercise may have been factors that explain the lack of difference of the SJFT variables (number of throws, HR, index, MIP).

In this context of intermittent exercise and judo physiological characteristic involving sequential attacks supported by the adenosine triphosphate and phosphocreatine (ATP-PCr) system contribution, the oxidative metabolism may still play a critical role to supply the energy cost of judo matches lasting several minutes [Franchini, Artioli, Brito 2013; Julio *et al.* 2017], and to further studies, the ergogenic respiratory mechanisms need to be better interpreted. Therefore, the high-intensity exercise performance enhancement with IMW (lower loads of 40% MIP, and higher breath repetitions protocols) was previously reported [Wilson *et al.* 2014; Ozdal *et al.* 2016]. In our hypothesis this respiratory ergogenic aid mechanism, has a similar characteristic of hypocapnic voluntary hyperventilation protocols [Sakamoto, Naito, Chow 2014; Leithauser *et al.* 2016; Dobashi *et al.* 2017]. Specifically, the lower inspiratory loads substantially increase the baseline tidal volume, respiratory rate and reduce the partial pressure of exhaled carbon dioxide [Yanos *et al.* 1990]. Consequently, this hypocapnic hyperventilation induces alkalosis [Chin *et al.* 2007].

Several limitations of the present study should be acknowledged. Firstly, the inspiratory muscle strength measurements were taken using volitional, non-invasive techniques, which are better tolerated by participants than the use of balloon catheter systems [Taylor, How, Romer 2006; Kawabata *et al.* 2010]. Although other techniques such as magnetic stimulation and balloon catheters provide more detailed information on respiratory muscle function, maximal volitional maneuvers have been shown reliable and valid for the measurement of inspiratory muscle strength [Romer, Polkey 2008; McConnell, Griffiths 2010]. Secondly, the sample size is relatively low, which is due to the aim of the present study evaluating the effect of IMW in a specific population of elite athletes. Finally, the three experimental conditions were performed within the same day, potentially inducing some fatigue. We believe however that this design did not significantly affect the outcomes of the present study since the order of the experimental conditions was randomized and because these elite athletes were used to repeat intense judo exercises in their sports practice.

Conclusion

To our knowledge, the present study was the first to provide information related to the effect of IMW in combat sports, in conclusion, we found that high load IMW combined with specific judo warm-up did not improve judo performance in elite judo athletes. These results do not suggest that IMW may improve performance during intermittent high-intensity exercise such as judo throwing techniques executed intermittently. Aiming to achieve some benefit by respiratory optimization acutely before combats, sports scientists should focus more on voluntary hyperventilation strategy to increase the glycolytic metabolic energy release to increase this energy system contribution and, consequently, increase exercise performance rather than high load inspiratory warm up.

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Compliance with ethical standards

All authors declare that there are no conflicts of interest regarding the participant of this work.

The study design has been approved by the ethical committee of the Hospital de Clínicas de Porto Alegre/Brazil (Nº: 1.881.537). All participants signed their informed consent before entering the study. The study was conducted in adherence to the Declaration of Helsinki [World Medical Association, 2013].

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Brak wpływu wysokiego obciążenie mięśnia oddechowego na wyniki Specjalnego Testu Sprawności w Judo (SJFT)

Słowa kluczowe: judo, rozgrzewka wdechowa, mięśnie oddechowe, wyniki sportowe

Abstrakt
Tło. Mięśnie oddechowe mogą odgrywać ważną rolę w sportach walki, takich jak judo, w celu zaspokojenia dużego zapotrzebowania na wentylację i przyczynienia się do kontroli postawy.
Problem i cel. Określenie wpływu ćwiczeń mięśni wdechowych (IMW), jako specyficznej rozgrzewki mięśni oddechowych w losowo kontrolowanym badaniu klinicznym.
Metody. 11 zawodnikom judo przydzielono trzy różne protokoły rozgrzewki, a efekty ćwiczeń mięśni wdechowych zostały ocenione w specjalnym teście wytrzymałościowym (SJFT). Każdy judoka wykonał trzy różne protokoły rozgrzewki: rozgrzewka *uchi-komi* (kontrolowana); rozgrzewka plus IMW (2 zestawy po 15 oddechów z maksymalnym 60% ciśnieniem wdechowym); rozgrzewka *uchi-komi* plus symulacja rozgrzewki IMW (2 zestawy po 15 oddechów z maksymalnym 15% ciśnieniem wdechowym). Wydajność testu SJFT została oceniona po każdym typie protokołu rozgrzewki, podobnie jak i jak tętno (HR) oraz stopień odczuwanego wysiłku (RPE).
Wyniki. Nie stwierdzono wpływu protokołu rozgrzewkowego na całkowitą liczbę rzutów (p = 0,141), tętno po teście (p = 0,676), tętno 1 min po teście (p = 0,543) i wskaźnik wydajności (p = 0,240) SJFT. Jednak stopień oddczuwanego wysiłku różnił się w zależności od warunków (p = 0,037), w testach post-hoc Bonferroniego wskazującymi jedynie na tendencję do wyższych wartości w warunkach dużego obciążenia IMW w porównaniu do warunków kontrolnych (p = 0,061) i warunków placebo (p = 0,095).
Wniosek. Wysokie obciążenie mięśni wdechowych IMW nie poprawiło wydajności SJFT wśród najwyższej klasy judoków.