

Original Article

Impact of The Rest Period Duration and Breathing Techniques on Session RPE in Elite Kumite-Karate AthletesArsenijević Radenko ^{1*}Trikoš Bogdan ²Kojić Filip ³Toskić Lazar ⁴Marković Milan ⁵Utvić Nikola ⁶Aksović Nikola ⁷Lilić Ljubiša ⁸Stanković Veroljub ⁹Dobrescu Tatiana ¹⁰^{1,4,5,6,7,8,9}University of Pristina in Kosovska Mitrovica, Leposavić 28218, Serbia^{2,3}University of Belgrade, Belgrade 11000, Serbia³Preschool Teacher Training College Šabac, Šabac 15000, Serbia⁴University Union-Nikola Tesla, Belgrade 11000, Serbia⁹University of East Sarajevo, Pale 71420, Bosnia and Herzegovina¹⁰"Vasile Alecsandri" University of Bacau, 600115, Calea Marasesti, 157, Romania

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The aim of this study to investigate interdependent effects of rest periods duration and breathing techniques on session rating of perceived exertion, in elite-level kumite-karate athletes. Nine males and females, national Serbian team, performed six sessions with strike gyaku zuki. Every session had five series of gyaku zuki with 40 strikes, but the sessions had different rest periods and different breathing techniques (sessions with kime, kiai and without exhalation). When 15 minutes have passed since the end of every session, session rating of perceived exertion was collected. Procedure of the two-way within subject ANOVA have showed that short rest periods has caused ($p = 0.030$) higher perceptible load, compared to the long rest periods, and breathing techniques failed to reach level of significance ($p = 0.663$). The findings suggest that session rating of perceived exertion is sensitive to rest period duration in elite level kumite-karate training.

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1. Introduction

Monitoring the training process helps coaches and athletes to make more precise adjustments and thereby avoid negative outcomes such as overtraining and reduced performance (Meeusen et al., 2013). It is simply not possible to identify the effect of training without precise quantification and monitoring of training load (Mujika, 2013). Training load is described as an input variable that is manipulated to obtain desired training responses (Coutts et al., 2021; Impellizzeri et al., 2019). However, training load is most often described and quantified through measures of external and internal load (Bourdon et al., 2017; Impellizzeri et al., 2019; Impellizzeri et al., 2005). External load refers to the applied training load that the athlete perceived during training, and involves tracking objective workload variables (Bourdon et al., 2017; Impellizzeri et al., 2005). Internal load refers to indicators of the athlete's relative physiological and psychological response to applied training load (Impellizzeri et al., 2019). Measures such as heart rate, blood lactate level, and maximal oxygen consumption are objective measures of internal load (McLaren et al., 2018), and despite the established validity and objectivity of these methods, significantly more practical application lies in the subjective measures. Alternatively, a subjective internal method rating of perceived exertion (RPE), and its derivatives has been proposed for quantification of the internal load (Bourdon et al., 2017; Impellizzeri et al., 2019). So far, a strong correlation has been established between RPE and the objective (heart rate, blood lactate levels, oxygen consumption) as well biomechanical (e.g., kinetic and kinematic variables, electromyography) and psychological (mood state, motivation, mental stress) measures in many documented researches and through myriad training modalities (Borg, 1998; Lagally, McCaw, Young, Medema, & Thomas, 2004; Milanez et al., 2011; Robertson & Noble, 1997). The use of RPE is founded on the idea that athletes can rate their subjective stress levels during or after exercise, which can help in adjusting training stimulus in the training (Eston, 2012). There are two types of the RPE: a) set RPE the, one collected through exercises, and b) session RPE (sRPE), collected > 10 min. after exercises (Halson, 2014; Scott, Duthie, Thornton, & Dascombe, 2016). Our study is dealing with sRPE in the kumite-karate training.

Application of the different acute training variables, such as rest periods duration, in the acute training sessions can differ internal response of the athletes (Halson, 2014). This has been confirmed in studies (Farah et al., 2012; Rogers, Gill, & Beaven, 2024), which have been dealing on the resistance and endurance training, revealing that shorter rest periods result in increased fatigue (i.e. higher internal load) compared to ones that lasted longer. In a recent study, that have applied power training, differences between long (120 seconds) and short (60 seconds) rest period duration on set RPE were examined, with significantly higher RPE values in shorter rest periods (Arsenijević et al., 2023). Very important measure when designing acute training programs, especially when karate is analyzed, may be related to breathing technique (Migliaccio, Russo, Maric, & Padulo, 2023). Undeniably, breathing techniques could significantly alter internal responses and the functioning of the physiological systems (Guyenet, 2014; Wallin, Hart, Wehrwein, Charkoudian, &

Joyner, 2010). Additionally, breathing control has been confirmed to endure focus and concentration (Fincham, Strauss, Montero-Marin, & Cavanagh, 2023), that could improve sport performance, especially in karate. Because of the stated, the impact of breathing techniques may be particularly important in karate sport due to the specialized forms of breath control (Walters et al., 2021).

Karate is defined by explosive, intermittent, and quick movements performed either by the upper or lower part of the athlete's body (Chaabene, Hachana, Franchini, Mkaouer, & Chamari, 2012). There are two different forms of karate – kumite (sparring) and kata form (technique without an opponent). It is worth of the mentioning that a higher number of the researches (Beneke, Beyer, Jachner, Erasmus, & Hütler, 2004; Chaabène et al., 2014; Iide et al., 2008; Mori, Ohtani, & Imanaka, 2002) are dealing with kumite. Specifically, researches were focused on the physiological and performance analysis of the kumite-karate athletes, and centered around kumite matches. Results from these studies have described kumite-karate as brief, high-intensity activity, interspersed with extended periods of low-to-moderate-intensity actions, with the both aerobic and anaerobic metabolism involved. Instead, there is no documented data of kumite training specifics of and how training variables affects training load during kumite-karate training, especially in elite athletes. To this date, just one study (Milanez et al., 2011) analyzed the correlation between objective (heart rate, blood lactate) and subjective-RPE during a karate session, recording a strong correlations ($r = 0.91 - 0.96$). However, their study did not completely report how internal load is influenced by different training variables.

Because of the above-mentioned importance of rest periods duration in designing training, it is reasonable to assume that such application could alter internal load parameters during kumite-karate training. So far, the available literature on monitoring karate training is very limited, with no studies found that define acute training variables, or provide clearly described acute karate training. Further, it is vital to mention two distinct breathing techniques in karate: kime, involving the firming of the abdominal wall along with a clear and energetic exhale, and kiai, described as brief shout following kime, aiming to increase energy in a karate attack (Kotarska, Nowak, Szark-Eckardt, & Nowak, 2019). To our knowledge, no study has examined the effects of different karate breathing techniques on any internal load parameters to this date.

In the carried out experimental sessions of this research, gyaku zuki (GZ) technique was used, as technique that is the most used in kumite competition, with 70% and more of the scoring punches as result of this technique (Laird & McLeod, 2009). Therefore, the objective of the current study was to explore the interdependent impacts of the rest periods duration and breathing techniques on the sRPE in elite-level kumite-karate athletes. We hypothesized that sRPE will: a) demonstrate higher values in short rest periods (rest period duration 30 sec.) compared to long rest periods (rest period duration 90 sec.), and, b) somehow display difference in the different breathing techniques, of GZ performance.

2. Material and methods

Experimental Approach to the Problem

This study was designed as within-subjects, explored the interdependent effects of rest interval duration and breathing techniques on the session rate of the perceived exertion (sRPE) assessment in elite kumite-karat athletes. Participants were involved in one familiarization session and six separate randomized experimental sessions, where the *gyaku-zuki* (GZ) technique was executed with manipulations in rest period duration and breathing techniques. Subsequently, participants provided data on the sRPE at the end of each session.

The first session involved short rest (30 sec.) and *kime* as the breathing technique. In the second session, the designated breathing technique was *kiai*, with a 30 seconds rest interval between sets (short rest). The third session, in addition to short rests (30 seconds), required the strike to be performed without simultaneous exhalation. The remaining three sessions defined as long rest between sets, with the fourth session having *kime* as the designated breathing technique, the fifth session featuring *kiai*, and the sixth session executing the strike without simultaneous exhalation.

Sessions were randomized, allowing manipulation of the effects of the rest period duration and breathing technique. In all experimental sessions, information of the sRPE was collected at end of every of six separate experimental session.

Subjects. The subjects in this study consisted of 9 elite karate athletes (males = 6, females = 3). All participants are representatives of Serbian national karate team (World Karate Federation association), including medalists in national, Balkan, European, and world competitions, as well as participants in the World Series A events. The characteristics of the participants were as follows: age 20 ± 3.91 years; body height 1.81 ± 0.08 m; body mass 68.44 ± 10.26 kg; body mass index (BMI) 20.98 ± 2.56 kg/m². Participants did not report any health issues, and no injuries were recorded immediately before, during, or after the experiment that could affect the performance. Prior to the experiment, all participants were informed on the testing protocol and potential risks of the experiment. They were also required to sign an informed consent document. The study was approved by the faculty of sport and physical education - Institutional Review Board (No. 02 194/20-2, from 18.02.2020).

Procedure. The experimental sessions were conducted over a 12-day period at a beginning of the summer transitional period, with two days of rest between experimental sessions. Experiments were organized during summer Serbia karate team camp in the summer of the year 2022. Besides experimental sessions, in this camp were performed other training sessions, but in nature they were light, because camp took place in the begging of the between season transitional period. Note that this camp was chosen for experiment realization in counseling with Serbia karate team National coach. Participants executed the GZ strike in all six randomized sessions, consisting of 5 sets of 40 repetitions each (totaling 200 strikes per session). Rest interval duration between sets was manipulated to be either 1) 30 seconds, and, 2) 90 seconds, along with different breathing techniques: 1) with *kime*, 2) with *kiai*, and 3) without exhalation.

Participants performed the GZ technique from the "*fudo dachi*" stance,

involving a simultaneous step forward with the front leg, a strike with the opposite hand, trunk rotation, and the release of the back foot's heel, which remains in the stance. The researchers controlled the rhythm of the GZ strike.

Familiarization Session. This session involved collecting anthropometric measures and familiarizing participants with the experiment protocols. The research protocol included introducing participants to the RPE CR-10 scale (Table 1) and presenting the type of activity (GZ strike) used during the experiment and its execution method, which is well known and commonly used technique for athletes of that level. During familiarization with the RPE CR-10 scale, participants were shown the scale with both alphabetical and numerical labels and values, along with an explanation of its use with already described procedures (Sweet et al., 2004).

Table 1. RPE CR-10 scale

RATING	DESCRIPTOR
0	No perceived exertion
1	Very light
2	Light
3	Moderate
4	
5	Hard
6	
7	Very hard
8	
9	
10	Extremely hard

Experimental Sessions. Before the start of each session, all participants had a usual warm-up, consisting of 5 minutes of dynamic stretching exercises, 5 minutes of running exercises, and 5 minutes of specific karate exercises. Each experimental session involved performing the GZ strike in the air, without a sparring partner, following the rhythm set by the researcher. The strike was performed from the starting position of the "fudo dachi" stance, to which participants immediately returned to execute the next strike promptly. All participants performed the task (all 200 strikes) at maximum intensity. It is very important to state that because there were two different experimental rest period durations, two experienced researches carried out all experimental sessions, so all participants could simultaneously complete named sessions. The researchers instructed vocal commands to signal the start of testing, execution of strikes, and the end of testing. After every session, 10 minutes after its competition, participants' corresponding internal responses (sRPE) were collected.

Data Collection and Analysis. The experiment was conducted in a sports hall period, between 7:00 PM and 9:00 AM. Experimental sessions were taking part at the begging of the camp training sessions, so the fatigue couldn't influence on the data collection. The temperature in the hall ranged between 20°C and 23°C. The

familiarization session was designed to collect standard anthropometric measures and inform participants about procedures (exercise execution, preferred approach to the test, introduction to the RPE CR-10 scale). Anthropometric measures were taken by the same experienced researcher, following standard procedures recommended by the International Society for the Advancement of Kinanthropometry (Norton et al., 2000). Body height and weight were measured with an accuracy of 0.5 cm and 0.1 kg, and the Body Mass Index (BMI) was calculated from the obtained data.

Instruments. The instruments used in this research included a stopwatch, used to control the between-set rest period and the rhythm of strike execution (every 2 seconds), and the RPE CR-10 scale, through which participants assessed the subjective response of the perceived exertion.

Statistical analysis. Descriptive statistics were calculated for all experimental data as mean and standard deviation (SD). Normality distribution for all data was assessed by using Shapiro-Wilk test. A repeated measure two-way ANOVA was used to establish effects of applied independent variables (i.e., rest period duration: short vs. long, and breathing techniques: kime vs. kiai vs. without exhalation) on dependent internal load variable sRPE. A Greenhouse-Geisser adjustment was made to the degrees of freedom in case of violation of the sphericity condition. Follow up ANOVAs statistical analysis were processed according to detail explained procedures (Howell & Lacroix, 2012). When the interactions or main effects were revealed, Bonferroni post hoc test with adjustment was applied (Vincent & Weir, 2012).

The eta squared (η^2) was calculated for the ANOVAs interactions and main effects with the following classification for magnitude effects (Field, 2013): no effect ($\eta^2 < 0.04$), minimum effect ($0.04 < \eta^2 < 0.25$), moderate effect ($0.25 < \eta^2 < 0.64$) and strong effect ($\eta^2 > 0.64$). A significant level of $p < 0.05$ was used for all comparisons. All statistical procedures were analyzed by using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA) and Microsoft Office Excel 2010 (Microsoft Corporation, Redmond, WA, USA).

3. Results and Discussions

Session rate of perceived exertion (sRPE). The results of this subjective internal load measure are showed in Figure 1. Further, two-way interaction rest period duration \times breathing techniques have not reached significance ($p = 0.488$). Regarding the main factor analysis rest period duration have showed significance ($p = 0.030$), with rest period duration achieving moderate effect ($\eta^2 = 0.464$). On the contrary, the main factor breathing techniques failed to reach significance ($p = 0.663$).

This study aimed to explore the interdependent impacts of the rest periods duration and breathing techniques on the sRPE in elite-level kumite-karate athletes. Specifically, the authors hypothesized that sRPE will: a) demonstrate higher values in short rest periods (rest period duration 30 sec.) compared to long rest periods (rest period duration 90 sec.), and, b) somehow display difference in the different breathing techniques, of GZ performance. Note that these two factors (rest period duration and breathing techniques) were observed interdependently.

The results showed that rest period duration have showed significant effects

as independent main factor ($p = 0.030$).

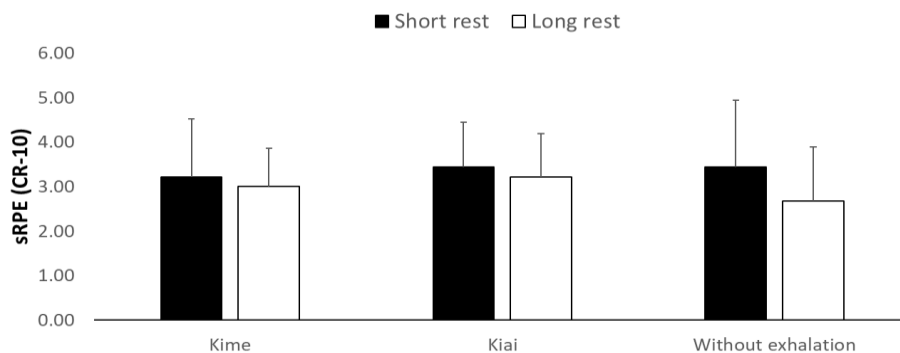


Figure 1. Graphic display of means and standard deviations of the subjective load variable session rating of perceived exertion (sRPE - expressed in values from CR-10 scale), for the rest period durations (short and long rest), breathing techniques (kime, kiai, and without exhalation)

Unfortunately, the interaction (rest period duration \times breathing techniques) and breathing techniques as main factor failed to show significant effects ($p > 0.05$). The following discussion will take attention on understanding and interpreting the main findings associated to the subjective internal load variable data.

Concerning rest period duration, the analysis of sRPE between short and long rest periods have revealed significant differences, showing higher short rest period values, compared to long rest period of sRPE. To this date, and to our knowledge, no studies have compared the independent or interdependent effects of rest period duration and breathing techniques in kumite-karate training. The most comparable studies were found in resistance training and body-weight power training, because of similar training structures like in our research.

Discussions

Unfortunately, we failed to find any study that was dealing with influence of the different rest period duration on sRPE in any training modality. Some similarities have three studies that have analyzed the effects of rest period duration on set RPE in resistance training (Farah et al., 2012; Larson Jr & Potteiger, 1997; Woods, Bridge, Nelson, Risse, & Pincivero, 2004), and one study was dealing with these problem in body-weight power training (Arsenijević et al., 2023). Two of the studies (Larson Jr & Potteiger, 1997; Woods, Bridge, Nelson, Risse, & Pincivero, 2004) results showed that the set RPE was similar between groups that executed different rest period duration in resistance training, but research by Farah and colleagues (2012), had different findings. In this research, differences in the set RPE between two protocols of the rest period duration were significant in the third set, and it should be highlighted that the rest period duration in the research (Farah et al., 2012) were shorter compared to other two researches (Larson Jr & Potteiger, 1997; Woods et al., 2004), which might have caused impact on muscle fatigue. Final research that has

some similarity with our study was by Arsenijevic and colleagues (2023), who analyzed influence of the different rest period duration sessions (60 sec. and 120 sec. between sets) on the set RPE in body-weight vertical jumping sessions. Results demonstrated that longer rest have showed lower subjective set RPE responses, compared to short rest.

Theoretical implications that are crucial were revealed in this study. Our findings suggest that rest period duration have showed effect on the subjective internal load of whole sessions, with long rest that provided lower responses of the internal load. From practical point of view, this research has drawn important findings for practitioner's and athletes while monitoring internal load, if they are trying to provoke different training stimulus (e.g., higher or lower fatigue) in kumite-karate training. Practitioners than should use shorter rest periods for higher perceived fatigue, and longer rest periods for lower perceived fatigue. Additionally, this was the first study, to our knowledge, that discovered and established influence of the rest period duration on sRPE in elite-level kumite-karate athletes.

Opposing to our second hypothesis, the main factor breathing technique failed to significantly made impact on the sRPE in kumite-karate athletes, suggesting that breathing technique is not relevant for fatigue induction in this study design, among elite-level kumite-karate athletes. Besides that, it is fair to mention that this finding is very important because no study, to this date, has explored the effects of specific breathing variants in martial arts training, which is difficult to compare our results with already published researches. However, some researches have observed the specifics of voluntary breathing and its effects on sports performance in different trainings (Blazek et al., 2021; Inbar, Weiner, Azgad, Rotstein, & Weinstein, 2000; Johnson, Sharpe, & Brown, 2007; Kilding, Brown, & McConnell, 2010). According to previous researches, specific breathing techniques can improve sports performance for some athletes by increasing respiratory muscles. Although different breathing techniques did not made impact on RPE levels in this study, it is reasonable to assume that breathing variants could affect kinetic and kinematic variables, or some other internal load variables, during striking specific karate techniques, such is GZ. Finally, future researches should deal with the examination of other training variables on both, external and internal training load, in karate-kumite training, which could promote understanding dose-response in kumite-karate training.

The current study has numerous positive sides. The sample was contained of the elite-level karate athletes. Furthermore, we focused on the GZ, the most usually used strike in kumite-karate training and competition (Laird & McLeod, 2009). To this date for the first time, we implemented structured training sessions with defined sets, repetitions, and rest period duration. Even though breathing technique did not show any significance, this was the first study to analyze influence of the kime and kiai in available literature, as this breathing techniques in karate training, and their influence on performance are still unknown, and they are unavoidable in this sport. Note that former studies have observed and monitored subjective and objective internal load in karate training but lacking with defined training volume and rest periods duration throughout the sessions (Johnny, Gianluca, Lucio, Vando, &

Cecilia, 2014; Milanez et al., 2011; Tabben et al., 2013).

About the limitations of the study, it should be specified that addition of the objective internal load variables (e.g., heart rate, blood lactate levels, etc.) could reinforced the findings of the study, but there a lot of validation of the relationships between sRPE and objective internal load variables (Eston, 2012). Additional limitation is participants quantity in the study, but is very hard to have accessible athletes of this level for experiments.

4. Conclusions

Our study emphasizes the magnitude of the rest period duration in kumite-karate training, since the obtained results evidently propose that longer rest period duration are producing a smaller amount of the subjective stress, compared to shorter rest period duration. When performing GZ, the variation with rest period duration in kumite-karate training is wanted in order to offer reduction/growth of the subjective fatigue. Hence, it could be resolved that the rest period duration unquestionably confirmed potential for its further application in organizing kumite-karate training. Regrettably, breathing techniques that are frequently used in karate, failed to show significance on subjective fatigue. It is essential to further explore its efficiency relating to other strikes and kicks in kumite-karate.

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