

# Tabata protocol-based high-intensity interval training in freestyle wrestlers

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## Abstract

**Background and Study Aim** The physical attributes of muscular strength and endurance are essential for wrestlers to perform successfully. For the development of these physical qualities, high intensity interval training (HIIT) using kettlebell strength exercises is appropriate. The purpose of this study was to develop a kettlebell HIIT program for wrestlers and evaluate the results on strength and endurance.

**Material and Methods** Eight freestyle wrestlers who participated in the Bulgarian Wrestling Championships (age: 22.0±2.17 years, wrestling experience: 9.9±2.80 years) were included in the study. Measurements included height, weight, 8 circumferences, 8 skinfolds, and BMI, body fat percentage (%BF), and skeletal muscle mass percentage (%SMM). The wrestlers engaged in an HIIT circuit that involved four rounds of 16 kg kettlebells and eight exercises, each lasting 20 seconds to complete and 10 seconds to recover between. Polar H7 was used to continually record heart rate (HR). At rest, before, immediately after, and 15 minutes after the HIIT, blood lactate concentration (La) was assessed. Each exercise's number of repetitions was noted.

**Results** The wrestlers' average height was 175.2±7.45 cm, their average weight was 85.1±13.38 kg, and their average BMI was 27.6 kg/m<sup>2</sup>. The SMM was 42.1±2.39%, and the BF was 10.3±3.98%. Heart rate (HR) exhibited a pattern of elevation from rest to warm-up and during circle 1 to 4, followed by a decrease 10 minutes after HIIT. Lactate levels (La) displayed an upward trend from rest to before HIIT, a significant increase after HIIT, and a decrease 15 minutes after HIIT.

**Conclusions** As shown by the fact that each wrestler's HR during the kettlebell HIIT was above 75% of HR<sub>max</sub> and that La was above the anaerobic threshold (>4 mmol/L), the created kettlebell HIIT, when used 5 times per week for eight weeks as part of the wrestlers' training, can improve their endurance.

**Keywords:** high-intensity interval training, heart rate, kettlebell, lactate, Tabata, wrestling.

## Introduction

High-intensity interval training (HIIT) is a form of interval workout, which typically lasts under 30 minutes, and it consists of brief intervals of maximal or supramaximal efforts with short recovery periods. For maintaining cardiorespiratory fitness, at least 150 minutes of moderate-intensity training or 60-75 minutes of vigorous-intensity training are recommended by the American College of Sports Medicine [1]. However, HIIT has been shown to be more time-efficient than the recommended intensity training, and it has similar aerobic benefits [2]. Moreover, Medbo and Burgers reported that 6 weeks of intermittent training can also increase the anaerobic capacity [3]. Specific HIIT composed of judo exercises was reported to substantially affect, both aerobic and anaerobic metabolisms, with relative contributions depending on the rest duration [4].

In 1996, Tabata et al. reported that performing a protocol of 4-minute HIIT (Tabata), which consisted of 8 sets (20 sec. work with 10 sec. rest, 170% VO<sub>2max</sub>), demonstrated similar increases in

aerobic performance when compared to participants performing 60 min of moderate-intensity (70% of VO<sub>2max</sub>) endurance training over an identical period of six weeks [5]. Furthermore, Tabata et al. concluded that the moderate-intensity endurance training did not affect anaerobic capacity but the Tabata HIIT protocol improves both anaerobic capacity and VO<sub>2max</sub> simultaneously [5]. This protocol has been used as method of training in combat sports [6, 7], and it has been shown to enhance sports performances which depends on aerobic and anaerobic energy-releasing systems during specific sports [8].

Similar to the popularity of HIIT training using Tabata protocol, kettlebells have also become popular in sports training [9]. Short 10-min. kettlebell training sessions (consisting of 35-second swing intervals followed by 25-second rest intervals) have been shown to elicit sufficient cardiovascular demand to improve aerobic capacity [10]. Moreover, kettlebell HIIT using Tabata protocol (8 sets of 20 seconds of maximal exercise followed by 10 seconds of rest) demonstrated significantly greater cardiovascular and metabolic responses vs traditional resistance kettlebell protocol [11].

Wrestling relies on all three energy systems to near maximal levels, so well-prepared conditioning programmes are needed. Throws, takedowns, and counters rely upon the ATP system, while mat control and clinching use the glycolytic system, and the aerobic system is used for surviving a prolonged match. Muscular strength and endurance are key physical qualities for the successful performance in wrestlers. Structurally, a wrestler needs a strong grip, shoulders, back, and leg power and endurance [12]. HIIT by using kettlebell exercises is suitable for the development of strength and endurance. Furthermore, traditional kettlebell swing may be an ideal exercise for HIIT workouts, and a useful addition to strength and conditioning programmes, due to its unique loading patterns [9], full-body integration, and its large mechanical demand, which aims to develop the ability to rapidly apply force [13]. Therefore, the aim of this study was to create kettlebell HIIT based on Tabata protocol and assess its effect on the cardiovascular and metabolic responses in wrestlers.

## Materials and Methods

### *Participants*

The study included 8 free style male wrestlers with a mean age of  $22.0 \pm 2.17$  years, and wrestling experience of  $9.9 \pm 2.80$  years. All participants were medallists at the Bulgarian Wrestling Championships, and three of them competed at the Freestyle Wrestling World Cup.

The wrestlers were informed about the purpose of the study, and signed informed consents were obtained, in accordance with the requirements of the Declaration of Helsinki for Human Research [14].

### *Research Design*

#### *Anthropometry*

The height, weight, 8 circumferences (neck, arm, chest, waist, abdomen, hips, thigh, and calf) and 8 skinfolds (pectoral, triceps, axilla, suprailiac, abdomen, subscapular, thigh, and calf) of each wrestler were measured. The circumferences were measured to the nearest 0.1 cm with the Lufkin W606PM tape measure, and the skinfolds were measured with the Lange Skinfold Calliper, Beta Technology Inc, Cambridge to an accuracy of 1 mm.

Body mass index (BMI) was calculated as: body weight in kilograms / height in metres squared. Waist-to-height ratio (WHtR) was calculated by dividing waist circumference (cm) by height (cm). Body fat percentage (%BF) was calculated by the sum of seven skinfolds, using Jackson & Pollock's equations for men [15]. Total body skeletal muscle mass (%SMM) was calculated by the arm, thigh and calf circumferences and skinfolds, using equations of Lee et al. [16]. Lean body mass (LBM) was calculated as body weight (kg) – body fat (kg).

### *Creating a circuit kettlebell HIIT workout*

The wrestlers performed circuit HIIT based on protocol of Tabata et al. [5], consisting of 4 circles of exercises with 16 kg kettlebells separated by 1 min rest. Each circle comprised of 8 sets with 20 sec. work at maximum effort, and 10 sec. rest between the exercises. The wrestlers were instructed to perform as many repetitions as they can during each 20 sec. work interval and place the kettlebell on the floor during rest. The HIIT workout consisted of the following exercises: #1 American kettlebell swing; #2 Kettlebell batwing gorilla row with 2 x 16 kg kettlebells simultaneously; #3 Kettlebell one-arm clean and press; #4 Kettlebell squat front raise; #5 Standing oblique kettlebell twist; #6 Kettlebell high pull; #7 One-arm kettlebell swing; #8 Kettlebell bent over row with 2 x 16 kg kettlebells simultaneously. The number of repetitions during the 8 exercises at each of the 4 circles were recorded and presented as absolute mean values (of the 4 circles) in each wrestler, and as mean (of the 4 circles) relative values per 100 kg body mass [ $100 \times \text{number of reps} / \text{body weight (kg)}$ ] in the whole group.

### *Heart rate (HR)*

Heart rate (HR) was registered continuously throughout the workout by using Polar H7 heart rate monitor and recorded 'beat by beat' with an accuracy of 1 ms. Maximal HR was calculated by using the Fox's equation:  $\text{HR}_{\text{max}} = 220 - \text{age [years]}$  [17].

### *Lactate concentration (La)*

La concentration in capillary blood from the earlobe was determined at rest, before the kettlebell HIIT workout, immediately after the workout and 15 min after the workout (recovery) by using LactatePro 2 LT-1730, Arkray Global Business Inc Japan.

### *Statistical analysis*

Spreadsheets created in Excel 2019 were used to conduct statistical analysis. The data is presented as mean  $\pm$  standard deviation (SD) in the text and tables and as mean  $\pm$  standard error (SE) in the figures.

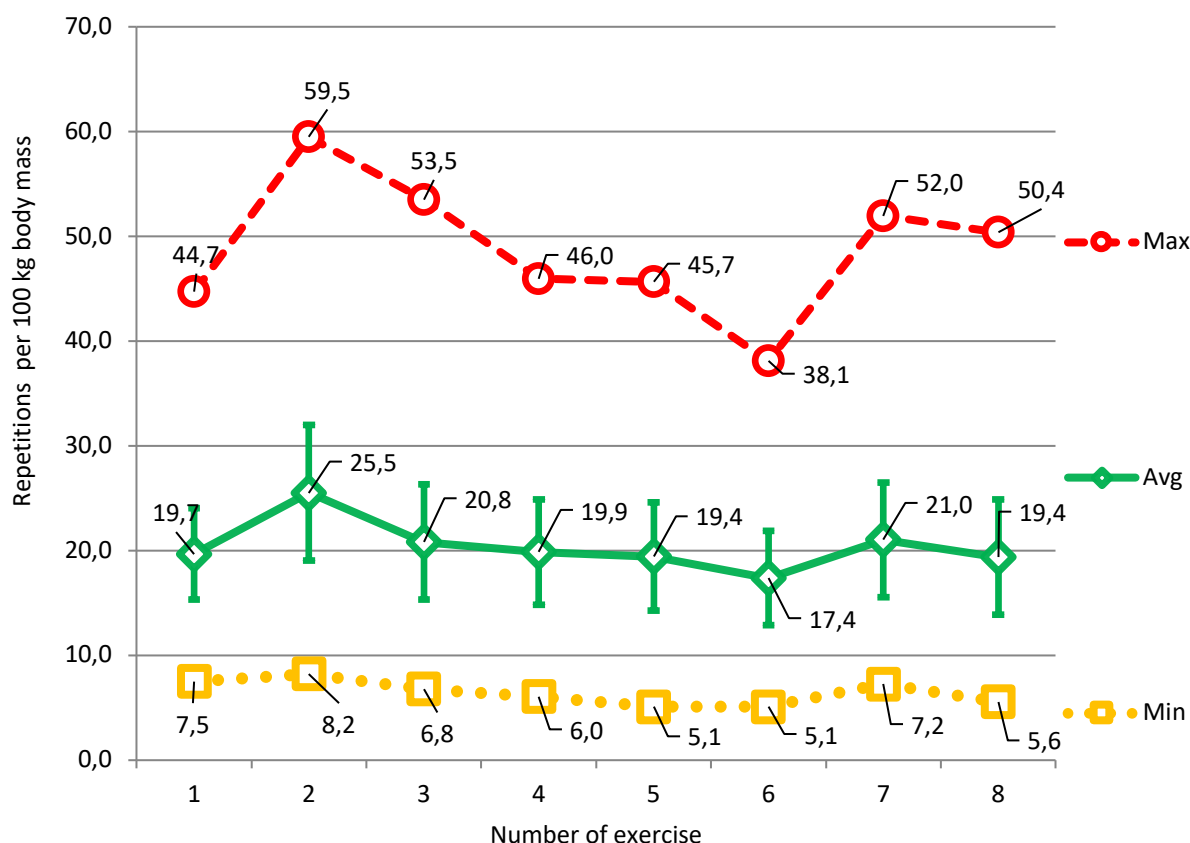
## Results

The age, sports experience, and the anthropometric parameters of the wrestlers are presented in Table 1. The mean and the individual BMI in 6 of the 8 wrestlers was greater than the accepted cut-off value of 25.0 kg/m<sup>2</sup> for normal weight. All of the wrestlers had normal body fat below 15% (which is lower than the WHO upper limit of 20% for men), and except one of the wrestlers, they had greater than 40% SMM (the upper limit for non-trained men).

The number of repetitions for each kettlebell exercise after the 4 circles x 8 sets kettlebell HIIT

**Table 1.** Age, wrestling experience, and anthropometric parameters of the wrestlers (n=8).

Parameter	Age [years]	Experience [years]	Weight [kg]	Height [cm]	BMI [kg/m <sup>2</sup> ]	%BF [%]	SMM% [%]	WHtR	LBM [kg]
Mean	22.0	9.9	85.1	175.2	27.6	10.3	42.1	0.49	75.9
Min	19.2	7.0	68.8	164.0	23.3	4.4	39.1	0.45	63.1
Max	25.6	15.0	103.5	188.0	33.1	15.5	45.8	0.55	88.2
SD	2.17	2.80	13.38	7.45	3.26	3.98	2.39	0.03	9.63
SE	0.77	0.99	4.73	2.64	1.15	1.41	0.84	0.01	3.41
C.V.%	10%	28%	16%	4%	12%	38.4%	5.7%	6.3%	12.6%



**Figure 1.** Maximum, minimum, and average values of mean relative repetitions (per 100 kg body mass) for each of the 8 kettlebell exercises in the wrestlers (n = 8).

workout are presented as relative values per 100 kg body mass in Figure 1. The relative mean reps of exercises 1 to 8 were between 17 and 25 repetitions.

The number of mean absolute repetitions for each wrestler after the 4 circles x 8 sets kettlebell HIIT workout are presented in Figure 2.

The mean heart rate (HR) of the wrestlers at rest, before the kettlebell HIIT workout, during the warm-up, as well as at each of the 4 cycles including the rest between cycles, and after the kettlebell HIIT workout, are presented in Figure 3. Heart rate (HR) exhibited a pattern of elevation from rest to warm-up and during circle 1 to 4, followed by a decrease 10 minutes after HIIT. The individual mean HR of each wrestler during the whole kettlebell HIIT workout was above 75% of HRmax.

The maximum, minimum and mean blood lactate concentration (La) at rest, before the kettlebell HIIT workout, immediately after the workout and 15 min after the workout (recovery) are presented in Figure 4. Lactate levels (La) displayed an upward trend from rest to before HIIT, a significant increase after HIIT, and a decrease 15 minutes after HIIT (recovery).

## Discussion

The BMI values did not provide accurate assessment of the weight and the body composition of the wrestlers. Two wrestlers were assessed as obese (BMI > 30 kg/m<sup>2</sup>), four as overweight (BMI > 25 kg/m<sup>2</sup>), and the other two wrestlers were within the normal limits for BMI established by the WHO (18.5 kg/m<sup>2</sup> - 25.0 kg/m<sup>2</sup>) [18]. BMI has been shown

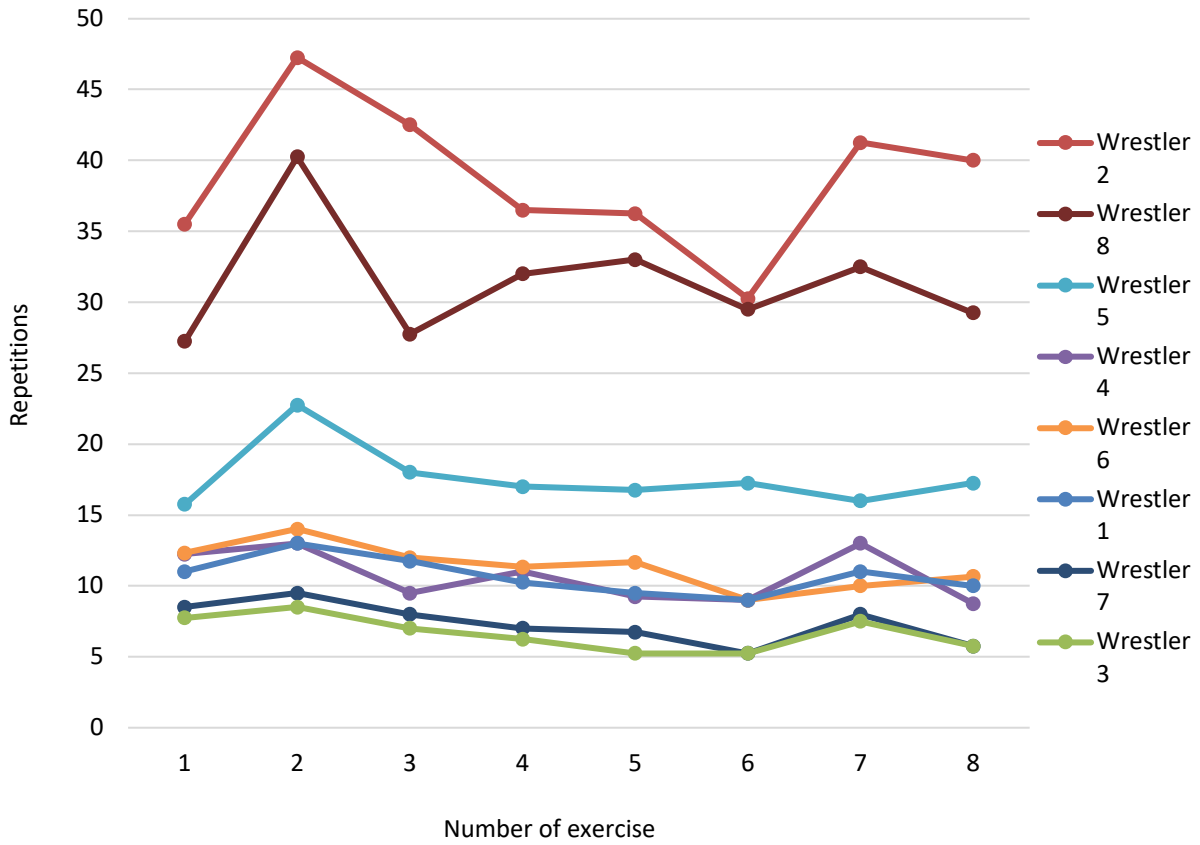


Figure 2. Mean absolute individual repetitions for each of the 8 kettlebell exercises.

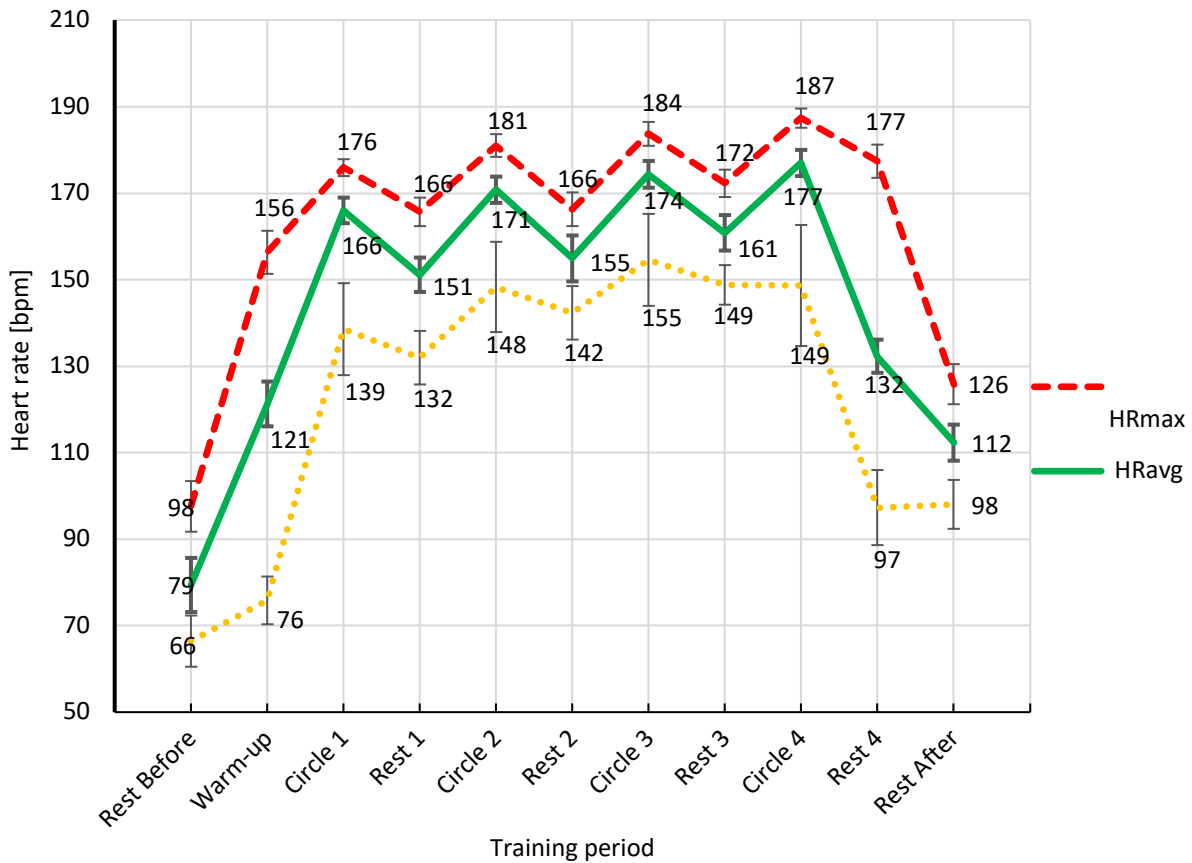
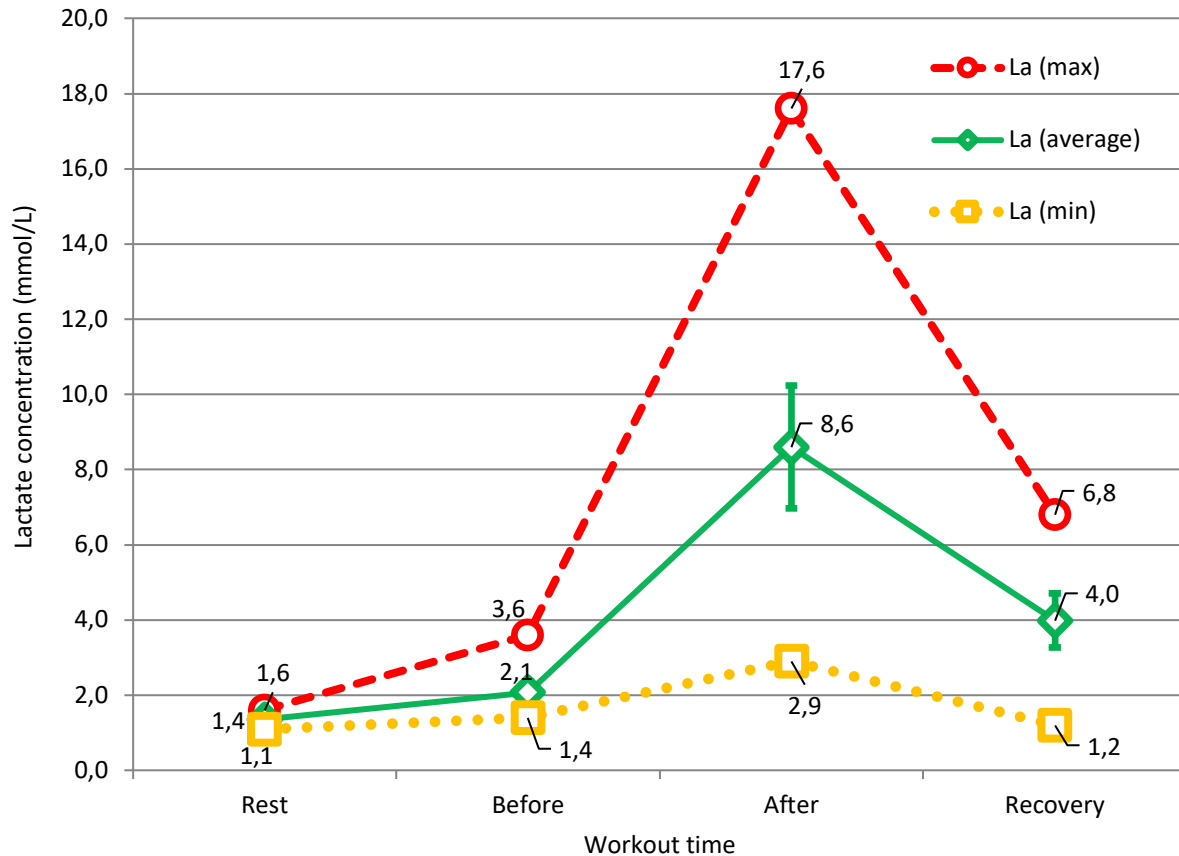


Figure 3. Maximum, minimum, and mean heart rate (HR) values of the wrestlers (n=8) throughout the kettlebell HIIT.



**Figure 4.** Maximum, minimum, and mean values of the lactate concentration (La) in the wrestlers (n = 8) at rest, before, immediately after, and 15 min after the kettlebell HIIT workout.

to be an inappropriate method for assessing body weight in elite athletes from power sports [19]. It has been recommended that BMI should be used in a combination with parameters, such as %BF and WHtR for more accurate assessment [20-22]. In fact, none of the wrestlers was overweight or obese, as it can be seen from the results of their %BF (from 4.4% to 15.5%), and their %SMM,  $42.1 \pm 2.39\%$  (Table 1). In addition to low %BF similar to that published for international level male wrestlers,  $11.4 \pm 3.01\%$  [23], the mean WHtR of the wrestlers in our study was below the cut-off of 0.500, which is used to assess increased health risk in relation to an excessive accumulation of body fat [21].

Kettlebell swing exercises have been described as unique form of training, which can be applied in strength and conditioning programmes [9, 13, 24]. The rapid and rhythmic nature of kettlebell exercises was reported to produce greater than maximal level of resistance in the posterior chain (hamstrings, gluteus maximus, erector spinae muscle group, trapezius, and posterior deltoids), which sometimes exceeds values measured during a maximal voluntary contraction [24]. Strength improvement in the muscles of the posterior chain is of particular importance in strength sports, such as wrestling. The presented kettlebell HIIT workout in our study involves all of those muscles.

Fortner et al. examined the characteristics of repetitive kettlebell swings with HIIT using Tabata protocol, and reported that kettlebell swing demonstrated significantly greater cardiovascular and metabolic responses versus traditional resistance protocol with kettlebell swing. Moreover, the authors concluded that kettlebell swing using Tabata interval framework can safely and effectively provide exercise adaptations with a relatively short time investment [11]. The weight of the kettlebell in their study was 4.5 kg for females, and 8 kg for males in contrast to one or two 16 kg kettlebells used by the wrestlers in our study. The kettlebell weight should correspond to the weight that the subject can swing with proper technique [24], and, therefore, studies designed to identify the most suitable weight, frequency, volume, and periodization of kettlebell swing using Tabata protocol are needed to determine the most appropriate and efficient load. It is suggested that the use of larger kettlebells, for example 16 kg for men, and 8 kg for women, would result in even greater cardiovascular and metabolic contributions [11]. Based on the results from our study, it was concluded that the kettlebell weight should be increased for 2 wrestlers (#2 and #8) and decreased for 2 wrestlers (#3 and #7), (Figure 2), in order to achieve optimal number of repetitions (10-15 reps) for improving muscular strength.

Fortner et al. reported maximal HR values during kettlebell HIIT using the Tabata protocol significantly higher vs traditional resistance protocol (162.4±4.6 vs 145.6±4.8 bpm; p<0.01) [11]. In our study, the wrestlers reached their highest mean HR of 177± bpm at the 4th circle of the kettlebell HIIT workout (Figure 3). The higher values could be explained with the heavier weight of the kettlebells in the wrestlers from our study (16 kg vs 8 kg). Furthermore, Fortner et al. also reported higher mean La values using the Tabata protocol vs traditional resistance protocol (6.4±1.1 vs 3.7±0.5 mmol/L; p<0.01). Similarly, the mean La values during the 20 min HIIT workout in our study was 8.6±4.61 mmol/L, which is above the anaerobic threshold of 4 mmol/L [25], and based on the high cardiovascular response (HR > 75% of HRmax) of each of the wrestlers, it can be assumed that in a period of 8 weeks, this workout applied 5 times per week can lead to improvements in athlete's aerobic endurance, respectively VO<sub>2</sub>max [26].

The kettlebell HIIT workout presented in our study includes 4 circles of 4 minutes work separated

by 1-minute rest, which is suitable training workload for freestyle wrestling match (2 periods of 3 minutes with a 30-second break in between).

## Conclusions

In order to achieve an optimal number of repetitions (10-15 reps) for improving muscular strength, it was recommended to adjust the kettlebell weight in those wrestlers who performed too many or too few reps. Further research is needed to establish the most suitable weight, frequency, and volume of kettlebell swing using Tabata protocol.

The individual HR of each wrestler during the kettlebell HIIT workout in this study was above 75% of HRmax, and the La was above the anaerobic threshold (>4mmol/L), which indicates that the presented kettlebell HIIT, applied 5 times per week in a period of 8 weeks as part of the wrestler's training, can lead to improvements in their endurance.

## Conflict of interests

The authors declare that there is no conflict of interests.

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