Differences in metabolic and cardiac response during recovery in wrestlers of different competitive levels

Article · July 2021

CITATIONS
0

READS
31

6 authors, including:

Filip Kukic
Abu Dhabi Police
97 PUBLICATIONS **452** CITATIONS
SEE PROFILE

Milan Markovic
Faculty of Sport and Physical Education, University of Pristina
28 PUBLICATIONS **179** CITATIONS
SEE PROFILE

Ivan Zarić
University of Belgrade
16 PUBLICATIONS **107** CITATIONS
SEE PROFILE

Lazar Toskic
Faculty of Sport and Physical Education, University of Priština-Kosovska Mitrovica
30 PUBLICATIONS **105** CITATIONS
SEE PROFILE

Serbian Journal of Sports Sciences
2021, 12(3): 57 - 62
UDC 612.14/.17:796.81-056.242

ISSN 1820-6301
COBISS.SR-ID 55911177

Original article
Received: 17 July 2021
Accepted: 19 Avg 2021

DIFFERENCES IN METABOLIC AND CARDIAC RESPONSE DURING RECOVERY IN WRESTLERS OF DIFFERENT COMPETITIVE LEVELS

Filip Kukić[1,2], Milan Marković[1], Ivan Zarić[1], Lazar Toskić[3,4], Miloš Mudrić[1], Dragan Radovanović[5]

[1]Faculty of Sport and Physical Education, University of Belgrade, Belgrade, *SERBIA*.
[2]Physical Fitness Testing and Research, Police Sports Education Center, Abu Dhabi Police, *UAE*.
[3]Faculty of Sport and Physical Education, University of Prishtina, Leposavić, *SERBIA*.
[4]Faculty of Sport, University ''Union – Nikola Tesla'', Belgrade, *SERBIA*.
[5]Faculty of Sport and Physical Education, University of Niš, Niš , *SERBIA*.

Abstract Wrestling combat causes the body to respond by increased heart rate (HR) and accumulation of blood lactates (La) to near maximum or maximum. The evidence to whether higher proficiency wrestlers perform better and recover faster due to more efficient cardio-metabolic system is scarce. This study aimed to investigate the difference in HR and La response during an initial five minutes of recovery after specific wrestling performance test (SWPT). The sample of male competitive wrestlers of different proficiency were allocated into three groups Level 1 (highest), Level 2, and Level 3 (lowest). Wrestlers performed SWPT and number throws (Tn^{Throws}) was recorded, while HR and La were collected during recovery. HR was measured at the end of the test and after five minutes into recovery and relative (%) change (ΔHR_{5min}) was recorded. La level was collected three (La_{3min}) and five (La_{5min}) minutes into recovery and used for the analyses. Relative La change (ΔLa_{3-5min}) was calculated as difference between La_{3min} and La_{5min}. Multiple analysis of variance with the Bonferroni post-hoc ($p<0.05$) calculated the between-group difference. Level 1 wrestlers performed better ($p<0.01$) in Tn^{Throws} than Level 2 and 3. Level 2 performed better ($p<0.01$) than Level 3. Level 1 wrestlers had larger ($p<0.01$) ΔHR_{5min} than the Level 2 and Lever 3. In addition, small to moderate difference occurred in La_{3min} and La_{5min}, with Level 1 having lower values. Wrestlers of higher proficiency had advanced specific adaptation of cardio-metabolic system to perform better and recover faster than the wrestlers of lower proficiency.

Key words: wrestling performance, sport physiology, sport biology, heart rate, blood lactate

INTRODUCTION

Wrestling combat characterizes the utilization of specific techniques with constant interplay between the tempo and rhythm of attacking and defensive actions invariable and unpredictable situational conditions [10,19]. These actions must be performed in maximal and submaximal intensity, which primarily depends on physical preparedness of wrestlers. The specificity of wrestling combat reflects in high energetic demands that are mostly provided from anaerobic-glycolytic pathways [11]. This dominant usage of the energy from anaerobic-glycolytic metabolism causes wrestler's body to respond by increasing the heart rate (HR) and accumulating the level of blood lactates (La) to near maximum or maximum [9,13].

According to Robergs et al. [21], increased La production coincides with cellular acidosis and remains a good indirect marker for cell metabolic conditions that induce metabolic acidosis. In addition, La concentration has been used as an indicator of physiological response aimed at providing insight into glycolytic metabolic recruitment and speed of recovery [2,5]. These data could further be used to estimate muscle stamina and/or fatigue and general preparedness of athletes [1,12,19,26]. Therefore, La response to wrestling performance during combat as well as recovery, could be used to monitor wrestlers' progress and the level of preparedness [16,17]. On the other hand, the heart rate (HR) response reflects the cardiovascular function during the activity and recovery and it is often presented in absolute values obtained through heart rate monitor [3,4,26]. Although absolute HR has been associated with maximal oxygen

consumption and training load [3,15], it could be misleading in evaluation of changes in cardiovascular response during activity (i.e., increase in HR) and recovery (i.e., reduction of HR) of athletes [22,24].

Considering the difficulty to perform testing in wrestling-specific combat conditions, the wrestler's metabolic response has been commonly observed in experimental controlled fights and specific tests [16,17]. However, there is a lack of studies on physiological responses (i.e., La increase or decrease) to specific wrestling activity, especially during recovery. Therefore, the aim of this study was to investigate the blood La and cardiac output characteristics of competitive wrestlers of different proficiency level during the recovery. It was hypothesized that wrestlers of higher proficiency have better metabolic and cardiac responses (i.e., faster recovery) for the higher level of performance.

METHODS AND MATERIALS

SUBJECTS

The sample consists of 57 male wrestling competitors who were allocated into three groups relative to wrestling proficiency: Level 1 (i.e., national team members, N = 15), Level 2 (i.e., compete nationally and regionally, N = 20), and Level 3 (i.e., compete only nationally and rank lower than Level 2 competitors, N = 22). The main characteristics were: Level 1 – age = 20.5 years, body height (BH) = 170.1 cm, body mass (BM) = 69.3 kg, and body mass index (BMI) = 23.89 kg/m^2; Level 2 – age = 22.4 years, BH = 173.4cm, BM = 78.9 kg, and BMI = 26.17 kg/m^2; Level 3 - age = 21.4 years, BH = 179.9 cm, BM = 87.1 kg and BMI = 29.96 kg/m^2. None of the participants was younger than 18 years of age. The mean competitive experience for Level 1, Level 2 and Level 3 was 11.1, 9.9, and 6.1 years, respectively. The mean weekly number of trainings of Level 1, Level 2 and Level 3 was 7.3, 7.2 and 6.6, respectively. All examinees and their trainers were familiar with the testing conditions. They voluntarily participated in the research and signed the written consent. The research was carried out in accordance with the conditions of the declaration of Helsinki, recommendations guiding physicians in biomedical research involving human subjects [25], and with the ethical approval number 484-2 of the ethical board of the faculty.

SPECIFIC WRESTLING PERFORMANCE TEST (SWPT)

Participants performed a general 10-minute warm-up consisting of variations of running on a wrestling mat, strength and mobility exercises. This was followed by an additional five minutes of specific warm-up of throwing a partner or a wrestling dummy. The SWPT was conducted according to previously reported procedure which was shown to be reliable (ICC = 0.721 - 0.953) [16] and sensitive ($p < 0.001$) [17]. The SWPT closely reflects the duration and intensity of the wrestling fight [18]. It consisted of two 3-minute rounds divided by 30-second rest, aiming at mimicking the time of one round in a wrestling fight. During the first round, participants performed as many suplex dummy throws as possible within the following time-repetition structure: the first 30 seconds participants performed single dummy throw each 10 seconds; the following 20 seconds participants performed maximal number of throws; and for the 10 seconds they were resting passively. The same sequence was repeated three times, except for the third time where instead of having 20 seconds of maximal number of throws and 10 seconds of passive rest, the participants performed maximal number of throws in 30 seconds. The second 3-minut round was identical to the first one. The total number of completed throws at the end of the second round was recorded for the analysis. All participants performed with the dummy adjusted to their body weight category, thus comprising similar relative load. The participants whose BM was below 74.9 kg were throwing a 22-kg dummy; participants who were 75.00 - 89.9 kg were throwing a 27-kg dummy; and participants over 90.00 kg were throwing a 32-kg dummy.

METABOLIC AND CARDIAC RESPONSE

The lactate concentration was analyzed using a portable new generation lactate analyzer (Lactate Plus-NOVA biomedical, USA), using a lactate biosensor based on lactate oxidization (Lactate Methodology – Lactate oxidase biosensor) [8,14]. The samples were collected from the capillary blood, each time from a different finger by an experienced researcher [6,16]. For the invasive part of collecting a blood sample, a single-use lancet Unistik 3 Comfort (Owen Mumford Ltd. UK) was used. The HR was recorded as a functional measure of the cardiovascular system caused by an applied load. For this purpose, a H7 Polar Heart Rate Sensor (Polar, Inc., Lake Success, NY, USA) was used. It was placed around the participant's chest before the test.

Considering the specificity and complexity of the techniques used in aforementioned tests, the same tester was controlling the correctness of actions of each participant during the tests in order to avoid the interrater differences. The second tester was controlling the timing and giving the instructions regarding the active and passive phases throughout the tests. The third tester was making sure to collect the HR of each participant at the correct timings. The testers verbally supported participants during the test in order to maximize their motivation and extract the maximum effort.

VARIABLES

The main performance measure was the total number of throws (Tn^{Throws}) from the start to the end of the test, which represented specific preparedness. The HR and La level were used as indicators of the achieved load of cardiovascular system and achieved metabolic acidosis. The HR was recorded at the end of the test (HR_{0min}) expressed in beats per minute (bpm) and five minutes after, and was expressed as a relative (%) change in HR during the five minutes of recovery (ΔHR_{5min}). The La concentration was collected in the third (La_{3min}) and the fifth (La_{5min}) minute of recovery an indicator of post-effort metabolic acidosis, expressed in mmol/L. Moreover, the relative difference in La concentration from third to fifth minute of recovery (ΔLa_{3-5min}) was used to indicate the relative change in La concentration during recovery.

STATISTICAL ANALYSIS

All analyses were carried out using the statistical package for social sciences (IBM, SPSS 20.0). Mean and standard deviation (SD) were calculated for each outcome measure. Kolmogorov-Smirnov test was used to evaluate the normality of data dispersion. Between-group differences were determined using multiple analysis of variance (MANOVA), while the Bonferroni post-hoc was used to calculate the difference between individual groups. The significance level was set to $p < 0.05$. Cohen's effect sizes (*d*) were calculated as the ratio of difference in mean scores to standard deviation. Following formula was used: $d = (M2-M1)/SD$, whereas M1 and M2 were the means of the groups investigated and the SD was a pooled standard deviation of compared groups. The magnitude of the effects was defined as follows: small = 0.20-0.59, moderate = 0.60-1.19, large = 1.20-1.99 and very large ≥ 2.0 [23].

RESULTS

The mean and SD for all outcome measures relative to wrestling proficiency are provided in Table 1. Among Level 1 wrestlers, La level increased during recovery in six (40%) and decreased in nine (60%) of participants. In Level 2 wrestlers, La increased in three (15%) and decreased in seventeen (85%) of wrestlers. In Level 3 wrestlers, La increased in seven (32%) and decreased in fifteen (68%) of wrestlers. The K-S test confirmed the normality of data distribution of each variable in each group ($p = 0.289 – 0.998$). Considering the results relative to wrestling proficiency, significant differences occurred in Tn^{Throws} ($F = 76.44$, $p < 0.001$, $\eta^2 = 0.038$), and ΔHR_{5min} ($F = 5.540$, $p = 0.006$, $\eta^2 = 0.170$), while La_{3min}, La_{5min}, ΔLa_{3-5min}, and HR_{0min} did not differ between the groups.

Table 1. The descriptive statistics relative to proficiency level

Variables	Group	Mean	SD	Minimum	Maximum
Tn^{Throws} (No)**	Level 1	47.47	3.36	41.0	53.0
	Level 2	40.60	4.22	31.0	46.0
	Level 3	30.91	4.41	24.0	41.0
La_{3min} (mmol/l)	Level 1	12.17	2.09	9.0	17.0
	Level 2	13.31	2.16	10.0	17.5
	Level 3	12.91	2.53	8.4	17.1
La_{5min}(mmol/l)	Level 1	11.76	2.07	7.0	14.0
	Level 2	12.69	2.51	9.6	17.4
	Level 3	12.40	2.40	7.4	16.0
ΔLa_{3-5min} (%)	Level 1	-2.87	12.62	-23.5	27.3
	Level 2	-4.93	8.07	-23.8	9.1
	Level 3	-3.65	8.02	-14.6	15.4
HR_{0min} (bpm)	Level 1	186.73	11.62	174.0	211.0
	Level 2	185.45	6.64	168.0	195.0
	Level 3	186.00	7.20	174.0	196.0
ΔHR_{5min} (%)*	Level 1	42.17	4.07	36.3	49.0
	Level 2	38.02	4.14	29.0	43.8
	Level 3	38.08	4.12	30.4	44.1

*Significant at $p < 0.05$, ** Significant at $p < 0.001$. Tn^{Throws} - total number of throws including both rounds, La_{3min} - lactate level after three minutes of rest, La_{5min} - Lactate level after 5 minutes of rest, ΔLa_{3-5min} - relative change in La level obtained in third and fifth minute of recovery, HR_{0min} - heart rate at the end of the test, ΔHR_{5min} – relative change in heart rate, after five minutes of rest. Level 1 - National team, Level 2 - First league competitors, Level 3 - Second league competitors.

The pairwise analysis showed that the Level 1 wrestlers were significantly better in Tn^{Throws} than the Level 2 and Level 3, and that Level 2 performed better than Level 3 (Table 2). In addition, Level 1 wrestlers had larger ΔHR_{5min} than those of Level 2 and Level 3. Considering the effect size, differences were larger in performance than in HR measures, which could be observed in relative differences as well (Figure 1).

Table 2. The differences between the groups relative to wrestling proficiency

Variable	Between-group comparison		Mean Difference	95% Confidence interval		t	p	Cohen's d
				Lower	Upper			
Tn^{Throws}	Level 1	Level 2	6.87	3.50	10.24	4.91	< 0.001	1.77
		Level 3	16.56	13.26	19.86	12.08	< 0.001	4.12
	Level 2	Level 3	9.69	6.64	12.74	7.67	< 0.001	2.24
ΔHR_{5min}	Level 1	Level 2	4.15	0.77	7.54	2.96	0.014	1.01
		Level 3	4.09	0.77	7.40	2.97	0.013	1.00
	Level 2	Level 3	-0.07	-3.13	2.99	-0.05	1.000	-0.02

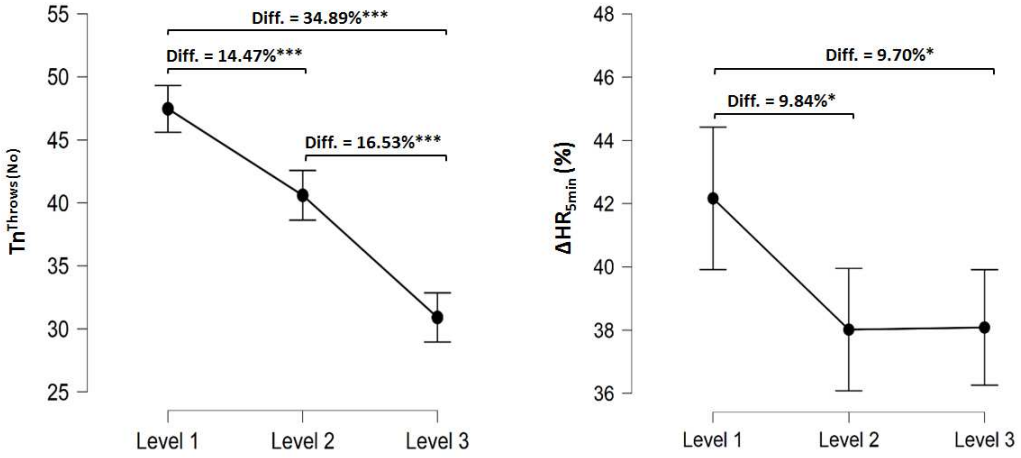

Figure 1. Pairwise comparison between the wrestlers of different proficiency. Tn^{Throws} – total number of throws, ΔHR_{5min} – relative change in heart rate after five minutes of rest. Level 1 – national team, Level 2 – first league competitors, Level 3 – second league competitors. * Significant at level $p < 0.05$, *** Significant at level $p < 0.001$.

DISCUSSION

This study aimed to investigate the blood La and cardiac output characteristics of competitive wrestlers of different proficiency level during the initial recovery after SWPT. The main findings showed that the wrestling proficiency defines how many throws a wrestler can perform for the duration of SWPT. National team wrestlers performed higher in Tn^{Throws}, followed by a faster HR recovery within the first five minutes, while there was no difference in La removal rate. Therefore, for the higher performance level, national team wrestlers have higher rate of HR recovery and similar La level compared to wrestlers of lower proficiency level. Accordingly, the hypothesis of this research was true. Although La levels did not differ between proficiency levels, wrestlers of higher proficiency performed higher at similar La level, indicating better specific training adaptation.

Specific adaptations to training were further supporter by the consistency of differences between the wrestlers of varying proficiency level as even wrestlers Level 2 performed higher than Level 3, despite having similar cardiac and metabolic response. This was also confirmed by Markovic et al. [16] who found significant differences in SWPT performance between two levels of wrestling proficiency [17]. Furthermore, Karničić et al. [12] investigated La accumulation during wrestling match in national team competitors and

club-level wrestlers, whereby the matches were held between the competitors of the same level. They found that more proficient wrestlers had significantly lower La levels after the first and second bout, indicating that for the higher effort they had lower metabolic response, which was different to the results obtained in current study. It is of note that in each proficiency level blood La of some wrestlers during an initial phase of recovery was reducing, while in others was increasing. This suggests that metabolic type of athlete [20] does not affect the wrestling-specific performance among wrestlers of same proficiency level.

The anaerobic-glycolic activity leads to high production of blood La, which is why the power of aerobic metabolism (i.e., cardiovascular function) is of high importance for wrestlers during recovery in order to accelerate the removal of La from the blood. Therefore, the training specificity corresponds to the requirements of the match, which leads to specific adaptations that occur on the level of muscle fibers, cardiac output and metabolic profile [7]. Considering this, it could be stated that wrestlers of higher proficiency had advanced adaptation of cardio-metabolic system to perform better and recover faster than the wrestlers of lower proficiency. Moreover, these differences may reflect disparities in player conditioning and skill level between competitive levels.

A few limitations should be pointed out before the final conclusion. The sample of participants in La related groups was relatively small, which could be the reason why at some places significant differences did not occur, even though the effect size was present. The La levels were collected only at two time points during recovery. This could be expanded to more time points of La samples during the effort, before and after 5th minute of recovery to establish the trend of La during recovery more precisely. The study could be repeated on all weight categories and some younger-age categories such as cadets and juniors, as well as on females.

CONCLUSIONS

The results of this study suggest that wrestlers of higher proficiency level perform better, for which they have the support from cardiac and metabolic profile obtained by specific training. In that regard, coaches should be choosing exercises, intensities, loads, and training tools, that support specific adaptation of biological systems that are responsible for the efficacy of performance and/or recovery of wrestler. The SWPT seems to be a valid tool for the evaluation of performance and belonging cardio-metabolic responses provides a valuable insight into wrestler's current status. Given that it provides the information about performance, cardiac and metabolic responses, coaches could evaluate their training programs with good precision. Because the SWPT revealed significant differences in Tn^{Throws} and ΔHR_{5min}, the test could be conducted even without collecting the La if the time and resources (i.e., trained specialist and equipment) do not allow it. However, La should be included in analysis when comprehensive evaluation of metabolic type of wrestlers is needed.

ACKNOWLEDGEMENTS

This research is part of the National Scientific Project "Effects of applied physical activity on locomotor, metabolic, psychological, social and educational status of the population of the Republic of Serbia", No. ID III 47015.

REFERENCES

1. Barbas I, Fatouros IG, Douroudos II, Chatzinikolaou A, Michailidis Y, Draganidis D, et al. Physiological and performance adaptations of elite Greco-Roman wrestlers during a one-day tournament. Eur J Appl Physiol 2011; 111(7):1421–36.
2. Brooks GA. Cell–cell and intracellular lactate shuttles. J Physiol 2009; 587(23):5591–600.
3. Chino K, Saito Y, Matsumoto S, Ikeda T, Yanagawa Y. Investigation of exercise intensity during a freestyle wrestling match. J Sports Med Phys Fitness 2015; 55(4):290-296.
4. Cottin F, Durbin F, Papelier Y. Heart rate variability during cycloergometric exercise or judo wrestling eliciting the same heart rate level. Eur J Appl Physiol 2004; 91(2):177-184.
5. Cruz RS de O, de Aguiar RA, Turnes T, Penteado Dos Santos R, de Oliveira MFM, Caputo F. Intracellular shuttle: The lactate aerobic metabolism. Sci World J 2012; 2012:420984.
6. Dopsaj M, Janković R. Validation of specific skills' polygon among students in the Academy of criminalistic and police studies: Metabolic and functional indicators for exercise. NBP - J Crim Law 2014; 19(1):185–99.
7. Fuku N, Kumagai H, Ahmetov II. Genetics of muscle fiber composition. In: Barh D, Ahmetov II, editors. Sports, Exercise, and Nutritional Genomics [Internet]. Academic Press; 2019 [cited 2020 Apr 22]. p. 295–314. Available from: http://www.sciencedirect.com/science/article/pii/B9780128161937000142.
8. Hart S, Drevets K, Alford M, Salacinski A, Hunt BE. A method-comparison study regarding the validity and reliability of the Lactate Plus analyzer. BMJ Open 2013; 3(2):e001899.
9. Houston ME, Sharratt MT, Bruce RW. Glycogen depletion and lactate responses in freestyle wrestling. Can J Appl Sport Sci 1983; 8(2):79-82.
10. Hübner-Wozniak E, Kosmol A, Lutoslawska G, Bem E. Anaerobic performance of arms and legs in male and female freestyle wrestlers. J Sci Med Sport 2004; 7(4):473–80.

11. Hübner-Woźniak E, Lutosławska G, Kosmol A, Zuziak S. The efect of training experience on arm muscle anaerobic performance in wrestling. Hum Mov 2006; 7(2):147–52.
12. Karnincic H, Tocilj Z, Uljevic O, Erceg M. Lactate profile during greco-roman wrestling matchx. J Sports Sci Med 2009; 8(CSSI3):17-19.
13. Kraemer WJ, Fry AC, Rubin MR, Triplett-Mcbride T, Gordon SE, Koziris LP, Lynch JM, Volek JS, Meuffels DE, Newton RU, Fleck SJ. Physiological and performance responses to tournament wrestling. Med Sci Sports Exerc 2001; 33(8):1367-1378.
14. Kulandaivelan S, Verma SK, Mukhopadhyay S, Vignesh N. Test retest reproducibility of a hand-held lactate analyzer in healthy men. J Exerc Sci Physiotherapy 2009; 5(1):30-33.
15. Lewis SF, Taylor WF, Graham RM, Pettinger WA, Schutte JE, Blomqvist CG. Cardiovascular responses to exercise as functions of absolute and relative work load. J Appl Physiol 1983; 54(5):1314–23.
16. Markovic M, Dopsaj M, Kasum G, Zaric I, Toskic L. Reliability of the two new specific wrestling tests: performance, metabolic and cardiac indicators. Arch Budo 2017; 13:409-420.
17. Marković M, Kasum G, Dopsaj M, Toskić L, Zarić I. Various competitive level wrestlers' preparedness assessed by the application of the field test. Phys Cult 2018; 72(2):170-180.
18. Markovic M, Kukic F, Dopsaj M, Kasum G, Toskic L, Zaric I. Validity of a Novel Specific Wrestling Fitness Test. J Strength Cond Res 2021; 35(Suppl 2):S51-S57.
19. Nilsson J, Csergö S, Gullstrand L, Tveit P, Refsnes PE. Work-time profile, blood lactate concentration and rating of perceived exertion in the 1998 Greco-Roman wrestling World Championship. J Sports Sci 2002; 20(11):939-45.
20. Qaisar R, Bhaskaran S, Van Remmen H. Muscle fiber type diversification during exercise and regeneration. Free Radic Biol Med 2016; 98:56-67.
21. Robergs RA, Ghiasvand F, Parker D. Biochemistry of exercise-induced metabolic acidosis. Am J Physiol Regul Integr Comp Physio 2004; 287(3):502–16.
22. Rodríguez-Fernández A, Sanchez-Sanchez J, Ramirez-Campillo R, Nakamura FY, Rodríguez-Marroyo JA, Villa-Vicente JG. Relationship between repeated sprint ability, aerobic capacity, intermittent endurance, and heart rate recovery in youth soccer players. J Strength Cond Res 2019; 33(12):3406-3413.
23. Sullivan GM, Feinn R. Using effect size - Or why the P value is not enough. J Grad Med Educ 2012; 4(3):279-282.
24. Watson AM, Brickson SL, Prawda ER, Sanfilippo JL. Short-Term Heart Rate Recovery is Related to Aerobic Fitness in Elite Intermittent Sport Athletes. J Strength Cond Res 2017; 31(4):1055–1061.
25. Williams JR. The declaration of Helsinki and public health. Bull World Health Organ 2008; 86(8):650-652.
26. Wright GA, Isaacson MI, Malecek DJ, Steffen JP. Development and assessment of reliability for a sandbag throw conditioning test for wrestlers. J Strength Cond Res 2015; 29(2):451-457.

Address for correspondence:

Milan Marković
Faculty of Sport and Physical Education
University of Belgrade
Belgrade
SERBIA
Phone (international): +381655306919
E-mail: mm_milanm@yahoo.com