Baltic Journal of Health and Physical Activity

Volume 11 | Issue 4 Article 1

2019

Anaerobic power and hydration status in combat sport athletes during body mass reduction

Anna Kurylas
Department of Sports Training, The Jerzy Kukuczka Academy of Physical Education in Katowice, Poland

Jakub Chycki
Department of Sports Training, The Jerzy Kukuczka Academy of Physical Education in Katowice, Poland, j.chycki@awf.katowice.pl

Tomasz Zajac
Human Performance Laboratory, The Jerzy Kukuczka Academy of Physical Education in Katowice, Poland

Recommended Citation

Kurylas A, Chycki J, Zajac T. Anaerobic power and hydration status in combat sport athletes during body mass reduction. Balt J Health Phys Act. 2019;11(4):1-8. doi: 10.29359/BJHPA.11.4.01

Baltic Journal of Health and Physical Activity 2019; 11 (4): 1-8
Journal of Gdansk University of Physical Education and Sport
e-ISSN 2080-9999

ORIGINAL

doi: 10.29359/BJHPA.11.4.01

Anaerobic power and hydration status in combat sport athletes during body mass reduction

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

Anna Kurylas[1] ABF, Jakub Chycki[1] CDE, Tomasz Zając[2] BEF

[1] Department of Sports Training,
The Jerzy Kukuczka Academy of Physical Education, Katowice, Poland

[2] Human Performance Laboratory,
The Jerzy Kukuczka Academy of Physical Education, Katowice, Poland

abstract

Background: Hydration is one of the most significant issues for combat sports as athletes often use water restriction for quick weight loss before competition. There is significant evidence to indicate that the hypohydration status impairs anaerobic performance. The aim of this study was to investigate if hypohydration, to reach a weight category, affects anaerobic performance.

Material and methods: Six well trained combat sport athletes, classified in the middleweight division, took part in the experiment. The hydration status and anaerobic performance parameters were evaluated at four points in time (t_1 – four weeks before fight, t_2 – two weeks before fight, t_3 – one day before fight, t_4 – the fight day). The hydration status was determined using urine osmolality (U_{OSM}) and urine specific gravity (U_{SG}) techniques. Anaerobic performance was evaluated by 30s Wingate tests for upper limbs.

Results: The current investigation demonstrated a significant impairment of anaerobic performance parameters, such as peak power – P_p (W), mean power – P_m (W) and total work performed – W_t (J), as a consequence of dehydration in the weight cutting process.

Conclusions: The overall results indicate that hypohydration in combat sports athletes is not fully compensated in the 24 h from weigh-in to competition.

Key words: hydration, rehydration protocol, anaerobic performance.

article details

Article statistics: **Word count:** 2,920; **Tables:** 0; **Figures:** 2; **References:** 19
Received: September 2019; **Accepted:** October 2019; **Published:** December 2019

Full-text PDF: http://www.balticsportscience.com

Indexation: Celdes, Clarivate Analytics Emerging Sources Citation Index (ESCI), CNKI Scholar (China National Knowledge Infrastructure), CNPIEC, De Gruyter - IBR (International Bibliography of Reviews of Scholarly Literature in the Humanities and Social Sciences), De Gruyter - IBZ (International Bibliography of Periodical Literature in the Humanities and Social Sciences), DOAJ, EBSCO - Central & Eastern European Academic Source, EBSCO - SPORTDiscus, EBSCO Discovery Service, Google Scholar, Index Copernicus, J-Gate, Naviga (Softweco, Primo Central (ExLibris), ProQuest - Family Health, ProQuest - Health & Medical Complete, ProQuest - Illustrata: Health Sciences, ProQuest - Nursing & Allied Health Source, Summon (Serials Solutions/ProQuest, TDOne (TDNet), Ulrich's Periodicals Directory/ulrichsweb, WorldCat (OCLC)

Funding: This research was supported by the Ministry of Science and Higher Education of Poland under Grant NRSA3 03953 and NRSA4 040 54.

Conflict of interests: Authors have declared that no competing interest exists.

Corresponding author: Jakub Chycki, Department of Sports Training, The Jerzy Kukuczka Academy of Physical Education in Katowice, 40-065 Katowice, Mikolowska 72a, Poland; e-mail: j.chycki@awf.katowice.pl.

INTRODUCTION

Combat sports are among the sport disciplines which have weight categories to make competition fair for athletes of different anthropometric characteristics. This phenomenon relates to the drastic reduction of body mass before competition in order to meet particular weight standards [1]. As research shows, most athletes do not incorporate long term dietary and training procedures to reach the optimal body mass for competition. On the contrary, the majority of combat sports athletes reduce their weight drastically before the competition to reach appropriate weight categories. This may mean a reduction of up to 5% body mass within 2–3 weeks or even a shorter time period. The analysis of dietary procedures of elite female judo athletes in the precompetitive period has revealed that 80% of them use very low calorie diets, which do not cover the basic energy needs, and in some cases reached values as low as 470 kcal/d [2]. The results of studies considering the effects of body mass reduction on physical and mental performance are quite controversial. There is research indicating that drastic weight reduction negatively influences repeated-effort performance, while other studies show no impact on aerobic and anaerobic single or repeated physical tasks [3]. It seems that large magnitudes of weight loss (> 3% BM) over a short period of time (24–48h) are detrimental to strength speed performance, while weight loss over multiple days (5–12) using food restriction and fluid manipulation have not shown negative effects on performance [4]. Studies that show a negative impact of weight reduction usually relate to high intensity repeat effort performance up to 24h following the weight loss [5, 6]. Combat sports with longer competition duration are likely to be at a greater risk of impaired performance resulting from rapid weight reduction. There are many methods of body mass reduction which have different consequences on sport performance. Acute reduction in energy intake influences performance through reduced glycogen concertation [4, 6]. Lower levels of muscle glycogen induce fatigue and lower the strength-endurance by reducing glycolytic potation. When using acute dehydration as a weight loss strategy, different physiological changes will influence exercise performance. Dehydration by sweat loss is associated with a reduction in blood plasma, and total blood volume which impairs the cardiovascular function, muscle blood flow and thermoregulation [5, 7]. The recovery period between weight control and competition is usually 24h or less, which seems insufficient to recover the hydration status [6, 7]. Some authors indicate that acute dehydration significantly alters electrolyte concentration which may influence cells fluid balance, and as a result impair the neuromuscular function [6, 8]. There is little research investigating the acute effects of dehydration and rehydration on the neuromuscular function and anaerobic performance in combat sports.

Considering the significant consequences of rapid weight reduction on physical performance in combat sports, we have attempted to evaluate changes in anaerobic power, body mass and body composition as well as the hydration status in elite athletes over four weeks' body mass reduction before competition

MATERIAL AND METHODS

PARTICIPANTS

Six, apparently well-trained combat sport athletes were enrolled in the study. All study participants had at least eight years of training experience and competed at the international level. Subjects were classified in the middleweight division (154–160 lbs, 69.85–72.56 kg). The athletes constituted a homogenous group with regard to age (average age of 27.3 ±0.5 years), somatic and anthropometric characteristics as well as anaerobic performance (mean body mass (BM) 79.4 ±1.1 kg; fat content (FAT%) 10.8 ±1.7%). All subjects had valid medical examinations and showed no contraindications to participate in the study. The athletes were informed verbally and in writing of the experimental protocol, the possibility to withdraw at any stage of the experiment, and they gave their written consent for participation. The experimental protocol was approved by the Ethics Committee of the Jerzy Kukuczka Academy of Physical Education in Katowice, Poland, and conformed to the principles presented in the Declaration of Helsinki.

Experimental design

The experiment lasted 29 days. The study consisted of four visits to the laboratory. The body mass, hydration status and anaerobic performance were evaluated at four points in time (t_1 – four weeks before fight, t_2 – two weeks before fight, t_3 – one day before fight, t_4 – the fight day) (Fig. 1). The study was conducted during the preparatory period of the annual training cycle, when a high volume of work dominated the daily training loads. The experiment reliably imitated the preparations for competition. In fact, the preparations are not crowned with a real fight. The exercise protocol would not be applicable on the day of competition. The participants refrained from exercise for 2 days before testing to minimise the effect of fatigue.

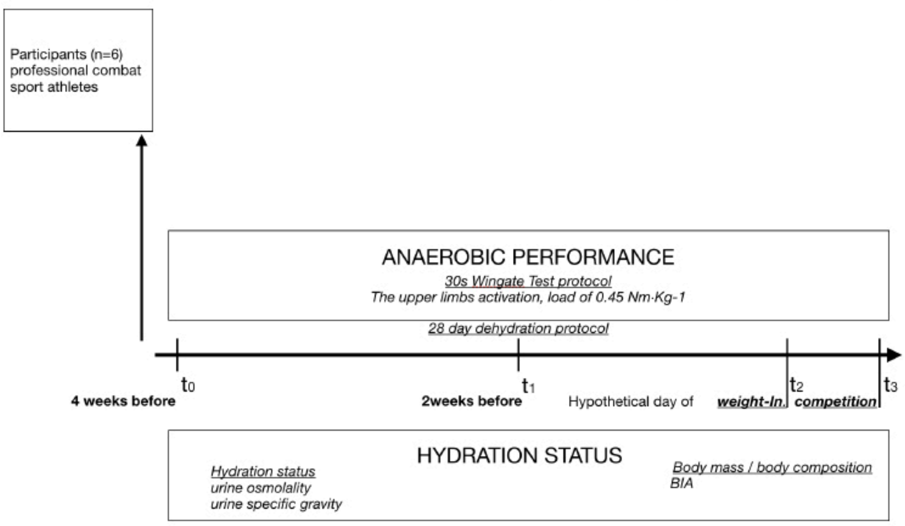

Fig. 1. Experimental design flowchart

Biochemical assays

Urine samples were taken at each of the four time points (t_1, t_2, t_3, t_4). They were placed in a plastic container and mixed with 5 ml/L of 5% solution of isopropyl alcohol and thymol for preservation. Urine samples were assayed for the presence of blood and proteins. Specific gravity was determined using the Atago Digital refractometer (Atago Digital, USA). Urine osmolality (U_{OSM}) was analysed in duplicate by freezing point depression osmometry (Model 3250, Advanced Instruments, USA).

Body mass composition

The measurements of body mass were performed on medical scales with a precision of 0.1 kg. Body composition was evaluated using the electrical impedance technique (Inbody 720, Bioscpace Co., Japan).

Stress test

Anaerobic performance was evaluated by the 30-second Wingate test protocol for upper limbs. The test was preceded by a 5 min warm-up with resistance of 40 W and cadence within 50–60 rpm. Following the warm-up, the test trial started, in which the objective was to reach the highest cadence in the shortest possible time and to maintain it throughout the test. The lower limb Wingate protocol was performed on an Excalibur Sport ergocycle with a resistance of 0.8 $Nm \cdot Kg^{-1}$ (Lode BV, Groningen, Netherlands). The upper body Wingate test was carried out on a rotator with a flying start with a load of 0.45 $Nm \cdot Kg^{-1}$ (Brachumera Sport, Lode, Netherlands). Each subject completed test trials. The variables of peak power – P_p (W), mean power – P_m (W) and total work performed – W_t (J), were registered and calculated by the Lode Ergometry Manager (LEM, software package, Netherlands).

Statistical analysis

The data were processed using the Statistica software and presented as means with standard deviations. The Shapiro-Wilk, Levene and Mauchly's tests were used in order to verify the normality, homogeneity and sphericity of the sample's data variances, respectively. The repeated measure ANOVA was performed to determine differences between four weeks before, two weeks before, one day before and the fight day for PP, MP, TW, LA, U_{OSM} and U_{SG}. The one way ANOVA was used to determine differences between values of body mass changes, after the hydration. Statistical significance was set at $p < 0.05$.

All statistical analyses were performed using Statistica 9.1 and Microsoft Office and were presented as means with standard deviations.

Results

Changes in P_p, P_m, W_t, LA, U_{OSM} and U_{SG} values, after hydration four weeks before the fight day, two weeks before the fight day, one day before the fight day and on the fight day were presented in Tables 1 and 2. Similarly, the changes in body mass values after the hydration were presented in Figure 2.

The ANOVA analysis of variance with repeated measures showed the most significant statistical differences in value of Pp between 1 day before the fight and on the fight day (with $p = 0.021$), after the hydration, as well as between 1 day before the fight and on the fight day in the values of P_m and W_t ($p = 0.039$ and $p = 0.036$). On the other hand, ANOVA showed the most significant statistical differences between 1 day before the fight and four weeks before the fight in the value of LA with $p = 0.040$ (Table 3).

The same ANOVA analysis of variance with repeated measures revealed the most significant statistical differences in values of U_{OSM} and U_{SG} between 1 day before the fight and on the fight day (with $p = 0.031$ and $p = 0.009$) after the hydration (Table 4).

Table 1. Changes in PP, MP, TW and LA values in the hydration status four weeks before the fight day, two weeks before the fight day, one day before the fight day and on the fight day

Variables	4 weeks before		2 weeks before		1 day before		Fight day	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
P_{p1}(W)	976.00	147.70	982.38	140.20	672.43	107.70	923.24	126.90
P_{m1}(W)	464.70	56.90	467.70	39.55	397.00	42.00	460.70	36.55
W_{t1} (J)	13412.60	1695.50	13971.60	1163.90	10393.60	1314.10	13271.60	1147.90
Δ LA mmol/l)	10.42	1.69	10.55	1.45	9.70	2.11	10.56	1.45

Table 2. Changes in U_{OSM} and U_{SG} values after hydration four weeks before the fight day, two weeks before the fight day, one day before the fight day and on the fight day

Variables	4 weeks before	2 weeks before	1 day before	Fight day
U_{OSM} (mOsmkg H_2O^{-1})	340.000	380.000	1121.300	780.800
U_{SG}	1.012	1.010	1.045	1.011

Table 3. Results of differences between four weeks before, two weeks before, one day before and on the fight day for PP, MP, TW and LA with ANOVA repeated measures

Variables	Measures	4 weeks before	2 weeks before	1 day before	Fight day
P_{p1} (W)	4 weeks before		0.231	0.034	0.167
	2 weeks before	0.231		0.032	0.189
	1 day before	0.034	0.032		0.021
	fight day	0.167	0.189	0.021	
P_{m1} (W)	4 weeks before		0.451	0.041	0.387
	2 weeks before	0.451		0.039	0.401
	1 day before	0.041	0.039		0.043
	fight day	0.387	0.401	0.043	
W_{t1} (J)	4 weeks before		0.397	0.040	0.333
	2 weeks before	0.397		0.038	0.405
	1 day before	0.040	0.038		0.039
	fight day	0.333	0.405	0.039	
Δ LA (mmol/l)	4 weeks before		0.114	0.040	0.314
	2 weeks before	0.114		0.043	0.714
	1 day before	0.040	0.043		0.043
	fight day	0.314	0.714	0.043	

Table 4. Results of differences between four weeks before, two weeks before, one day before and on the fight day for U_{OSM} and U_{SG} with ANOVA repeated measures

Variables	Measures	4 weeks before	2 weeks before	1 day before	Fight day
U_{OSM}	4 weeks before		0.124	0.021	0.041
	2 weeks before	0.124		0.012	0.034
	1 day before	0.021	0.012		0.031
	Fight day	0.041	0.034	0.031	
U_{SG}	4 weeks before		0.114	0.009	0.111
	2 weeks before	0.114		0.010	0.115
	1 day before	0.009	0.010		0.009
	Fight day	0.111	0.115	0.009	

One way ANOVA revealed significant statistical differences in the changes of body mass values after the hydration for one day before the fight with p = 0.021 and with reference to values for four weeks before, two weeks before and for the fight day (Fig. 2).

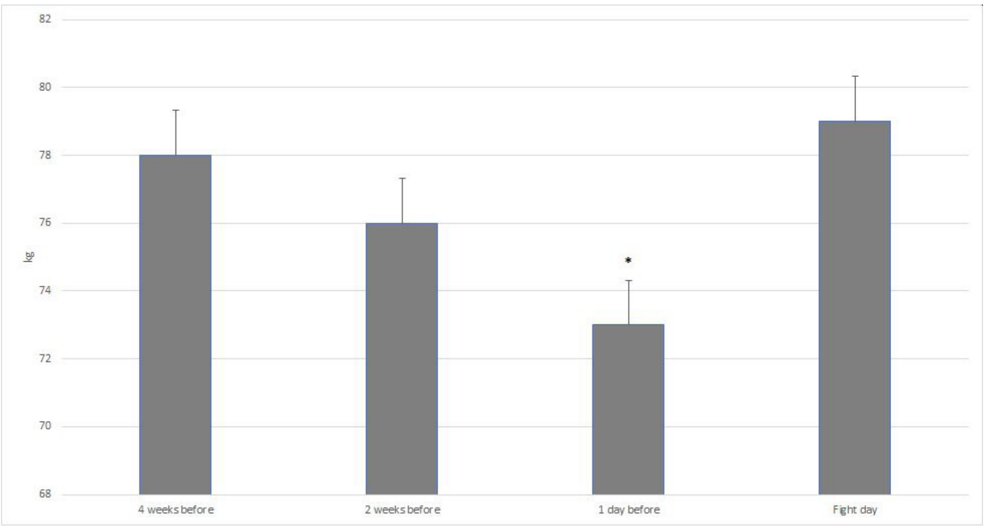

Fig. 2. Changes of body mass in the hypohydration protocol

DISCUSSION

There are such sport disciplines as combat sports for which fluid intake before, during and after competition is a key factor determining performance, as well as being part of the strategy for reaching the weight category limit [9]. Effective hydration determines proper functioning of the human body at rest and especially during and after exercise. Water allows for homeostasis; it facilitates most biochemical reactions; it allows numerous particles and compounds to dilute. It helps in the transport of metabolites and utilization of by-products [10, 11]. Exercise induces ionic changes within contracting muscles that contribute to the development of metabolic acidosis. The increased intramuscular acidity can then limit the capacity to perform exercise of high intensity [12].

In the present study, we investigated the effect of the hypohydration status on anaerobic performance of competitive combat sport athletes. The study participants were experienced athletes, capable of performing extreme anaerobic efforts and with the body mass reduction practice using energy and fluid restriction. We have chosen such an approach for two reasons. Firstly, it is well documented that hypohydration impairs aerobic and anaerobic performance. However, the majority of these research reports have been carried out in specific hydration statues, not presenting performance changes in increasing dehydration and after rapidly 24-hours hydration. Secondly, impairment of metabolism has been mostly discussed in the context of sedentary and recreationally active individuals [12]. Therefore, our study is novel by including both well-trained combat sport athletes and the use of protocol correlating an increasing hypohydration status with selected anaerobic performance parameters.

It is unclear how much hypohydration impairs anaerobic performance, and inconsistent results may be due to the use of different protocols to achieve hypohydration and measurements of strength and power abilities. Some authors have observed significant reductions in isometric and isokinetic force after 2% hypohydration [13], while others did not register significant changes in muscular activity even after 4% hypohydration [13, 14]. The current investigation demonstrated a significant decrease in anaerobic capacity (W_t – J) during a 29-day hypohydration protocol (from 13412.6 (J) – 4 weeks before to 10393.6 J – one day before the fight, $p = 0.0008$). This has been explained by an increase in core temperature which affects the sequence of muscle strength production by reducing motor cortex activation, peripheral stimulus and power output [10, 12].

The impairments in W_t were influenced by changes in U_{OSM} and U_{SG}. The results of the current study demonstrated a statistically significant increase U_{OSM} (from 340 (mOsmkg H_2O^{-1}) to 1131.3 (mOsmkg H_2O^{-1}), $p = 0.031$) and U_{SG} (1.012 to 1.045, $p = 0.009$) in the weight cutting process. For practical purposes, different methods of evaluating the hydration status are used. They include total body water content (bio-electrical impedance), blood variables (osmolality, volume, isotope tracers and sodium concentration), as well as urine variables (osmolality, volume, specific urine gravity). In our study, we used monitoring of U_{OSM} and U_{SG}. This choice is consistent with the suggestion of Popowski et al. [15], who compared the validity of U_{OSM} and U_{SG} to plasma osmolality and concluded that both are greatly correlated and are good measurements of hydration status.

The results of our study are in line with the available literature regarding the impact of hypohydration on P_p (W) and P_m (W). This phenomenon could be explained by the influence of the suppressed neuromuscular function, although membrane excitability is not reduced by dehydration [16]. It is well accepted that water is bound to the glycogen molecule in the cellular environment. Each gram of glycogen is stored in human muscle with at least three grams of water [17]. Olsson et al. assessed body water by tritium trace in dilution before and after glycogen loading, suggesting that each gram of glycogen was stored with 3–4g of water. Some authors sustain that different ratios of muscle glycogen to water following post-exercise glycogen repletion under different fluid intakes. A ratio of 1:3 was found when only 400 ml of water was consumed, while a ratio of 1:17 was determined when participants replaced the fluid lost during exercise [15, 18]. Despite numerous scientific data , there is still no conclusive answer regarding how much time is needed to recover fluid and energy substrates after a weight cutting protocol. Tarnopolsky et al. observed that the weight loss using energy and fluid restriction before weigh-in results in a marked decrease in muscle glycogen concentration which could affect high intensity anaerobic actions common in combat sports. However, those reductions in muscle glycogen concentrations are largely reversed during the 17-hour period allowed between weigh-in and the start of the competition [19]. The results of our study indicate that, despite 24h hydration, selected Wingate test parameters (P_p and P_m) were impaired if compared to the baseline value.

CONCLUSIONS

It seems that strength and power is significantly affected by a state of hypohydration in combat sports, where athletes usually dehydrate before competition to reduce body mass for a certain weight category. It is possible that full rehydration would have resulted in larger gains in neuromuscular performance.

REFERENCES

[1] Clarys P, Ramon K, Hagman F, Deriemaeker P, Zinzen E. Influence of weight reduction on physical performance capacity in judokas. J Combat Sport Martial Arts. 2010;1(2):71-76.

[2] Kwiatkowska-Pamuła A, Kurylas A, Perenc A, Ziółko E, Złotkowska R, Muc-Wierzgoń M. Assessment of nutrition in female judokas during the precompetitive body mass reduction period. 2017;4(24):183-7.

[3] Zubac D, Ivančev V, Karninčić H. Relationship between hypohydration and reduction rate of body mass among elite youth amateur boxers. Res Phys Educ Sport Health. 2015;4(2).

[4] Brito CJ, Roas AFCM, Brito ISS, Marins JCB, Córdova C, Franchini E. Methods of body-mass reduction by combat sport athletes. Int J Sport Nutr Exerc Metab. 2012 Apr;22(2):89-97. https://doi.org/10.1123/ijsnem.22.2.89

[5] Chycki J, Zając T, Maszczyk A, Kurylas A. The effect of mineral-based alkaline water on hydration status & the metabolic response to short-Term anaerobic exercise. Biol Sport. 2017;34:255-261. https://doi.org/10.5114/biolsport.2017.66003

[6] Karninčić H, Baić M, Slačanac K. Mood aspects of rapid weight loss in adolescent wrestlers. Kinesiology. 2016;48(2). https://doi.org/10.26582/k.48.2.7

[7] Morales J, Ubasart C, Solana-Tramunt M, Villarrasa-Sapiña I, González L-M, Fukuda D. Effects of rapid weight loss on balance and reaction time in elite judo athletes. Int J Sports Physiol Perform. 2018 Nov;18:1-7. https://doi.org/10.1123/ijspp.2018-0089

[8] Matthews JJ, Nicholas C. Extreme rapid weight loss and rapid weight gain observed in UK mixed martial arts athletes preparing for competition. Int J Sport Nutr Exerc Metab. 2017 Apr;27(2):122-129. https://doi.org/10.1123/ijsnem.2016-0174

[9] Franchini E, Del Vecchio FB, Ferreira Julio U, Matheus L, Candau R. Specificity of performance adaptations to a periodized judo training program. Rev Andaluza Med del Deport. 2015;8(2):67-72. https://doi.org/10.1016/j.ramd.2013.11.001

[10] Sahlin K. Muscle energetics during explosive activities and potential effects of nutrition and training. Sports Medicine. 2014;44:167-73. https://doi.org/10.1007/s40279-014-0256-9

[11] Fernández-Elías VE, Martinez-Abellán A, López-Gullón JM, et al. Validity of hydration non-invasive indices during the weight cutting and official weigh-in for Olympic combat sports. PLoS One. 2014;9 (4). https://doi.org/10.1371/journal.pone.0095336

[12] Chycki J, Kurylas A, Maszczyk A, Golas A, Zajac A. Alkaline water improves exercise-induced metabolic acidosis and enhances anaerobic exercise performance in combat sport athletes. PLoS One. 2018 Nov 19;13(11):e0205708. https://doi.org/10.1371/journal.pone.0205708

[13] Judelson DA, Maresh CM, Anderson JM, Armstrong LE, Casa DJ, Kraemer WJ. Hydration and muscular performance – Does fluid balance affect strength, power and high-intensity endurance. Sports Med. 2007;37(10):907-921. https://doi.org/10.2165/00007256-200737100-00006

[14] Hayes LD, Morse CI. The effect of progressive dehydration on strength and power; is there a dose-response? Eur J Appl Physiol. 2009;108(4);701-707. https://doi.org/10.1007/s00421-009-1288-y

[15] Popowski LA, Oppliger RA, Patrick Lambert G, et al. Blood and urinary measures of hydration status during progressive acute dehydration. Med Sci Sports Exerc. 2001;33:747-753. https://doi.org/10.1097/00005768-200105000-00011

[16] Costill DL, Coté R, Fink W. Muscle water and electrolytes following varied levels of dehydration in man. J Appl Physiol. 1976;40:6-11. https://doi.org/10.1152/jappl.1976.40.1.6

[17] McBride JJ, Guest MM, Scott EL. The storage of the major liver components; Emphasizing the relationship of glycogen to water in the liver and the hydration of glycogen. J Biol Chem. 1941;139(2):943-52.

[18] Fernandez-Elias VE, Ortega JF, Nelson RK, Mora-Rodriguez R. Relationship between muscle water and glycogen recovery after prolonged exercise in the heat in humans. Eur J Appl Physiol. 2015;115(9):1919-26. https://doi.org/10.1007/s00421-015-3175-z

[19] Tarnopolsky MA, Cipriano N, Woodcroft C, et al. Effects of rapid weight loss and wrestling on muscle glycogen concentration. Clin J Sport Med.1996;6:78-84. https://doi.org/10.1097/00042752-199604000-00003

Cite this article as:

Kurylas A, Chycki J, Zajac T.
Anaerobic power and hydration status in combat sport athletes during body mass reduction
Balt J Health Phys Act. 2019;11(4):1-8
doi: 10.29359/BJHPA.11.4.01