Acta Scientiarum

http://periodicos.uem.br/ojs
ISSN on-line: 1807-8648
Doi: 10.4025/actascihealthsci.v44i1.57233

Fluid intake, hydration status and body mass changes in U-15 judo athletes during a training day

Bayram Ceylan[1*] and Luis Santos[2]

[1]Department of Coaching Education, Faculty of Sport Sciences, Kastamonu University, Kuzeykent Campus, Kastamonu, Turkey. [2]Department of Physical Education and Sport, University of León, León, Spain. * Author for correspondence. E-mail: bceylan@kastamonu.edu.tr

ABSTRACT. Despite numerous studies related to dehydration there is still a lack of scientific literature presenting hydration status and fluid intake of judo athletes during different periods. Therefore, the aim of this study was to investigate, fluid intake, hydration status and body weight changes of young judo athletes during a typical day of training in preparation period. Twenty-two young judo athletes (age: 12 ± 0.7 y, experience: 3.5 ± 1.1) voluntarily participated in this study. Hydration status and weight were examined in the morning, before and immediately after the training. All athletes trained 90 min and they consumed fluids ad libitum during the exercise. According to morning urine specific gravity (USG) values, 81.2% of the athletes were dehydrated while only 18.8% of the athletes were euhydrated. Pre-training urine measurements showed that 63.64% of the athletes presented dehydration and 77.27% of the athletes completed the training in dehydrated condition despite fluid availability during the training. Mean body weight loss during training was -0.64 ± 0.66%. It can be concluded that young judo athletes presented high prevalence of dehydration as indicated by USG values. Most of the athletes were dehydrated during a typical training day and completed the training in more dehydrated conditions compared to pre training values despite ad libitum fluid intake. It is of great importance to evaluate hydration status of the athletes before training to refrain from common practice of fluid restriction for weight loss and adverse effects of a persistent state of fluid deficit on physical and health related state.

Keywords: hydration status; urine specific gravity; martial arts.

Received on December 26, 2020.
Accepted on March 15, 2021.

Introduction

Water is of great importance for human life. It plays an important role in all biochemical reactions that occur within the body and is a must for preserving blood volume (Meyer, Szygula, & Wilk, 2016). Considering that water has a role in physiological functions, it is not surprising that it also has an important role in maintaining exercise performance. The metabolic functions increase five-twenty times compared to its resting level during the training. This situation leads to an increase in body heat, which has to be annihilated to maintain thermal homeostasis (Hoffman, 2014). Hence, body fluid is sacrificed in order to hinder the increase in body temperature.

Dehydration refers to acute loss of body water (Sawka et al., 2007) and it is generally related to decreased plasma volume (Kavouras, 2002). It presents negative consequences for athletes. Dehydration is associated with a decrease in serum sodium levels and stroke volume, an increase in core body temperature, cardiac output, plasma fluid losses and hemoconcentration (Meyer et al., 2016). In addition, González-Alonso, Mora-Rodriguez, Below, and Coyle (1997) stated that dehydration yields adverse effects on cardiovascular functioning. Kavouras (2002) affirmed that even mild dehydration (1-2% of body weight) impairs athletic performance. Evidence-based studies suggest that dehydration of 3-4% of body weight impairs muscle strength, muscle power and endurance in high-intensity efforts lasting from 30 sec to 2 min. to the extent of 4-10% (Judelson et al., 2007). A review study about effects and physiology of dehydration highlighted that dehydration more than 2% decreases endurance, strength and power performance (Cheuvront & Kennefick, 2011). Moreover, studies report that dehydration adversely affects mood, concentration and cognition (Cian et al., 2000; Cian, Barraud, Melin, & Raphel, 2001; Baker, Conroy, & Kenney Jr., 2007a). It also affects muscle metabolism by accelerating the rate of glycogen depletion and central nervous system functioning by reducing motivation and effort.

Judo is a grappling sport where physical components (strength/muscle power, speed, agility, aerobic capacity and anaerobic capacity), technical components (throws, chokes, body shifting, etc.), tactical components (strategy used during the competition) and psychological components (anxiety, motivation and decision making) are of great importance for a better performance (Franchini, Branco, Agostinho, Calmet, & Candau, 2015; Detanico, Kons, Fukuda, & Teixeria, 2020). Given that judo is a very popular sport in the world and because judo competitions are carried out throughout the year, athletes are doomed to apply rapid weight loss beginning with very early age (i.e. 12.5 ± 2.2) (Berkovich, Eliakim, Nemet, Stark, & Sinai, 2016) and thus exposed to dehydration (Gurses, Ceylan, Akgul, & Baydil, 2018) and acute dehydration means health-related problems and injuries for most of the athletes (Meyer et al., 2016).

Previous studies investigated hydration status of judo athletes before and during a competition or training day (Rivera-Brown & De Félix-Dávila, 2012; Pettersson & Berg, 2014; Meyer et al., 2016; Gurses et al., 2018; Ceylan, Akgul, Gurses, Baydil, & Aydos, 2020; Ceylan, Baydil, & Aydos, 2021). Rivera-Brown and De Felix Davila (2012) monitored hydration status of adolescent judo athletes during training in a tropical environment and highlighted athletes started the training in a state of fluid deficit, drank insufficient amount of water and finished the training in a state of significant-to-serious dehydration. Pettersson and Berg (2014) evaluated hydration status in elite wrestlers, judokas, boxers, and taekwondo athletes on competition day and stated serious dehydration. Meyer et al. (2016) affirmed that fitness level and training status can considerably influence hydration state and rate of dehydration but not only young and inexperienced judo athletes but also older and more experienced athletes presented high level of dehydration as well. Ceylan et al. (2020) analyzed hydration status of elite judo athletes during a high level of competition and most of the athletes started and finished the competition day in a significant-serious dehydration state. Gurses et al. (2018) stated that judo athletes presented dehydration according to urine specific gravity (USG) values obtained before official weigh-in and two hours before competition despite 15 hours of recovery period. As even older judo athletes from a higher competitive level presented serious level of dehydration, young judo athletes should be monitored and accordingly informed about long-term adverse effects of dehydration.

Despite all aforementioned negative consequences of dehydration for athletes and even deaths of young athletes due to exercising in a *sauna* or with rubber suits with refraining from consuming fluid to induce dramatic dehydration (Centers for Disease Control and Prevention, 1998), very young judo athletes (U15) use dehydration–induced methods to lose weight (Artioli et al., 2010) and weight classified athletes still consult to rapid weight loss via sweating and fluid restriction (Artioli et al., 2010). Thus, as judo athletes' training comprises of high intensity exercises (Torres-Luque, Hernández-García, Escobar-Molina, Garatachea, & Nikolaidis, 2016) and it induces body fluid loss (Meyer et al., 2016) it is very important to monitor hydration status of the judo athletes and educate them, especially young athletes, to avoid these potential health and performance related risks.

Notwithstanding numerous studies investigating hydration status of elite or elder judo athletes, there is lack of literature related to hydration status and fluid intake of young judo athletes. Accordingly, the aim of this study was to determine the hydration status of a group of pre cadet (U15) Turkish judo athletes as well as their fluid intake and body weight changes during a training day. The overall study´s hypothesis was that these young athletes would present dehydration before and after the training and fluid intake would not be sufficient compared to fluid loss during training.

Material and methods

Participants

Twenty-two (14 males and 7 females) under-15 regional and national level Turkish judo athletes (12±0.7 years) agreed to participate in the project. The study was designed and completed in accordance with the guidelines contained in the latest declaration of Helsinki. A signed consent was obtained from the participants and their parents. Ethical approval of the study was provided from Kastamonu University Clinical Research Ethics Committee. Participants' morphological characteristics are showed in Table 1.

Inclusion criteria were the followings: active male or female regional or national level judo athletes, a minimum of two consecutive years competing at the regional or national level, and apparently healthy. To determine health status, participants underwent an examination conducted by the judo club medical staff. They were classified as healthy if they expressed the absence of neurological deficits, postural instability, vestibular or visual problems, musculoskeletal injuries, cardiovascular problems, injury to the neck, back pain

and lower extremity injuries for a minimum of six weeks prior to the time of evaluation. Individuals were excluded if they went through any illness.

Competitors' weekly training program included 7 to 9 sessions (90 min. each), 5-6 focused on technical-tactical training and 2-3 on conditioning. Participants routinely trained for 11 months per year. At the time of the present project, they were in the preparatory phase of their annual training plan. Hence, they were not in a period of rapid weight loss.

Table 1. Anthropometric characteristics of the athletes.

Variables (n = 22)	Mean ± SD
Age (years)	12 ± 0.7
Height (m)	1.52 ± 0.06
Weight (kg)	45.24 ± 8.4
BMI (kg m^{-2})	19.25 ± 2.6
Body fat (%)	20.37 ±5.3
Judo experience (year)	3.5 ± 1.1

Procedures

A descriptive study design was used to examine hydration status and fluid intake of young male and female regional and national-level judo athletes aged 10-13 years during a routine training day. All female athletes were asked about their menstrual period and they declared that none of them was in this period. On the first day, anthropometric measurements were carried out only for descriptive purpose and participants were provided with urine containers and told to bring urine samples next day for analysis. Athletes were not informed about the nature of the study and encouraged to hydrate. On the experiment day, when athletes had a typical judo training of preparation period (whose details were given in Table 2), athletes arrived at their training hall at 10.00 a.m. with their first urine samples and were weighted. Before and after the training urine samples were collected and athletes were weighted. All athletes were provided with water bottles and a researcher was assigned to follow their fluid intake throughout the training. Moreover, athletes were instructed not to modify their drinking habits and diet. The training lasted 90 min. Mean temperature in the training hall was 28.3 degrees and humidity was 56%.

Table 2. Training content of the judo athletes during measurement day.

Content	Time (min.)
Warm-up	10
Uchikomi	30
Randori in the standing and sitting position	30
Complimentary exercises	15
Cool-down	5
Total	90

Measurements

Body composition measurements were carried out with bioelectrical impedance device (Tanita, MC-980, Tokyo, Japan). Stature was determined with a stadiometer (Seca, 213, Hamburg, Germany) to the closest 1 cm. Hydration status of the athletes were assessed via urine specific gravity (USG) and the analysis were carried out with a digital refractometer (ATAGO, PAL-10S, Tokyo, Japan) whose reliability was presented with 0.96 correlation with an osmometer (Armstrong et al., 1998). USG values were classified as USG of ⩽ 1020 g mL^{-1} is indicative of being euhydrated (Popowski et al., 2001). Percentage of weight loss was calculated according to Scott, Horswill, and Dick (1994).

Statistical analysis

All values are shown as mean and standard deviation (SD) unless otherwise noted. The data normality and sphericity were confirmed according to Shapiro-Wilk's test and Mauchly´s test, respectively. A one-way analysis of variance with repeated measures (ANOVA) was performed to assess changes in the dependent variables (USG and total body weight) using time (morning, pre and post training) as the factor. When significant differences were found, *post hoc* analyses were performed using the Tukey *HSD*

post-hoc test. Pearson product correlation was used to verify relationship between fluid intake and USG change, fluid intake and BW change (%) from pre to post training. Correlation coefficients were classified according to Hopkins (2019) (0.0 = trivial, 0.1 = small, 0.3 = moderate, 0.5 = large, 0.7 = very large, 0.9 = nearly perfect, 1 = perfect). Statistical analysis was carried out with IBM SPSS 20 Statistics and significance was set at $p < 0.05$.

Results

Considering the USG values comparison (among the morning, pre and post training outcomes), there were no significant differences ($F_{1-21}=1.60$; p=0.22; ES=0.071 [small effect]) (Table 3).

Table 3. USG changes of the athletes at different measurement times.

Variable (n = 22)	Morning	Pre-training	Post-training	p
USG	1.022 ± 0.005	1.023 ± 0.004	1.024 ± 0.004	0.214
Body weight	45.3 ± 8.3	45.2 ± 8.4	44.9 ± 8.5	0.001

According to morning USG values, 81.2% of the athletes were dehydrated while only 18.8% of the athletes were euhydrated (Figure 1). In view of pre-training USG measurements, they displayed that 63.64% of the athletes presented dehydration. Despite fluid availability of all athletes during the training 77.27% of the athletes completed the training in dehydrated condition.

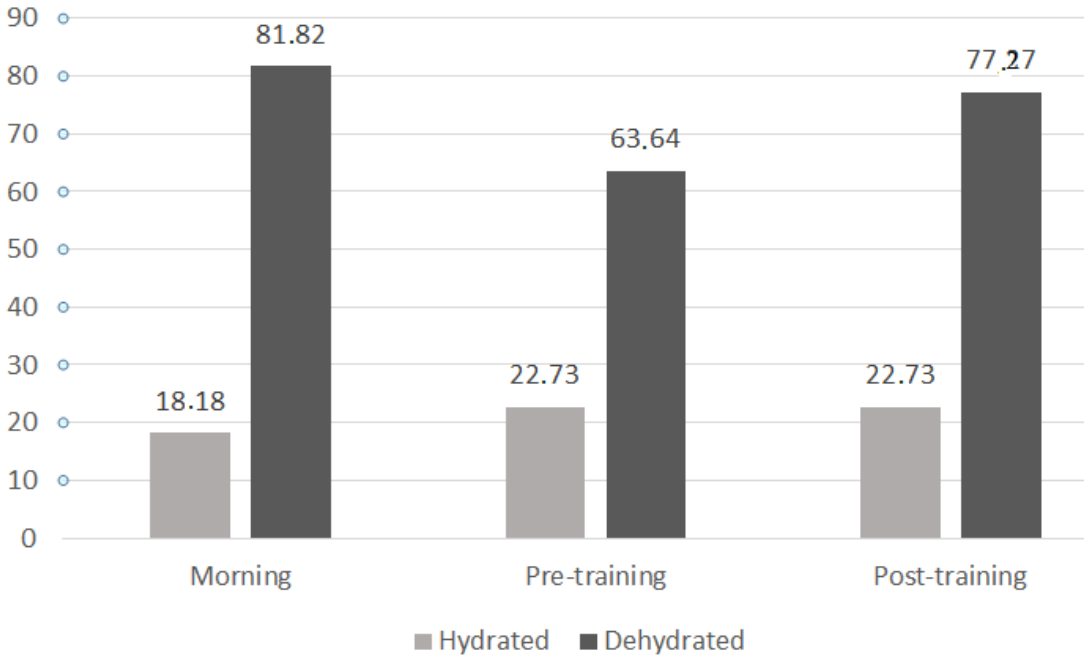

Figure 1. Percentages of hydrated and dehydrated judo athletes in the morning, pre and post training.

Regarding body weight, significant differences were found among measurements ($F_{1-21}=13.52$, $p < 0.000$). They were expressed between the pre-training and post-training data ($p = 0.000$) and between the morning and post-training ones ($p < 0.01$) (Table 3) [(weight loss percentage during the training was 0.64 ± 0.66% (-0.27 kg) (Figure 2)].

No significant correlations were found between fluid intake and body weight change percentage (r = 0.18 [Small]; p = 0.43; 95% Cis = -0.56 to 0.27) and between fluid intake and USG change percentage (r = -0.15 [Small]; p = 0.52; 95% Cis = -0.53 to 0.29).

This study aimed to investigate hydration status, fluid intake and body weight change of young judo athletes during a training day. The main findings of the study were that the majority of the athletes started practice in dehydrated state and maintained or even aggravated their pre-training hydration state despite fluid availability.

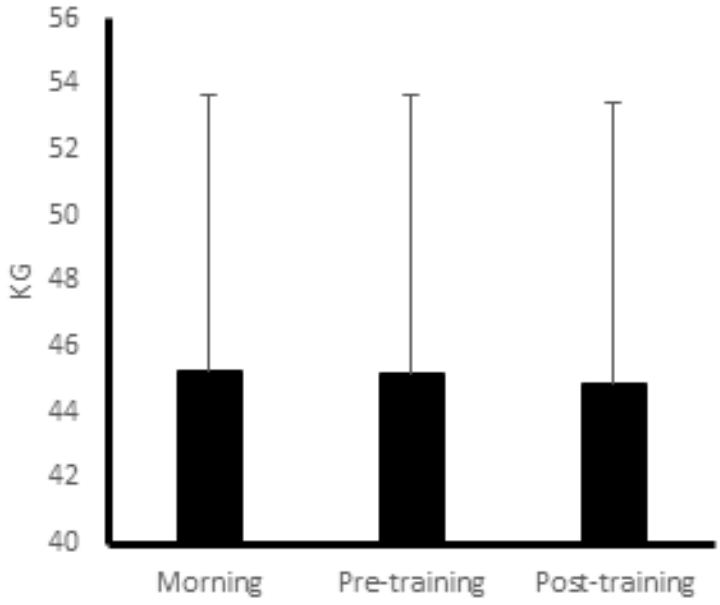

Figure 2. Changes in body weight in the morning, pre and post training.

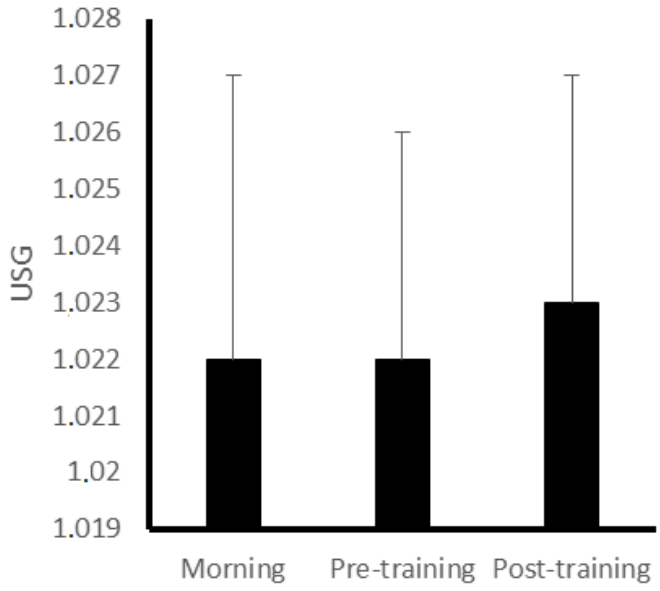

Figure 3. Changes in USG in the morning, pre and post training.

Discussion

Any given sport skill or task can be affected by neuromuscular, cognitive, and metabolic influences, and in any given circumstance, dehydration might mitigate one, some, or all components. For example, greater dehydration led to a decrease at a great extend in athletic skill and motor function (Edwards et al., 2007; Baker, Dougherty, Chow, & Kenney, 2007b). In addition, a study by Cheuvront, Carter, and Sawka (2003) attributed dehydration or hypohydration to deficit in cardiovascular impairment. A reduction in body water has been reported to negatively affect neuromuscular system (Hoffman, Staysky, & Folk 1995; Ftaiti, Grelot, Coudreuse, & Nicol, 2001) and muscle membrane excitability (Costill, Cote, & Fink, 1976). When athletes become dehydrated during exercise, they may be exposed to a greater physiological strain. Even low level of dehydration has been reported to lead to core temperature rises compared to well hydrated state (Casa et al., 2010).

Young athletes have been reported to start an exercise in a state of fluid deficit and they usually do not replace this deficit when drinking water ad libitum (Meyer et al., 2016). Likewise, in our study young judo athletes, who were not informed about the nature of the study, presented elevated first morning USG samples (USG < 1.020), which proved that the athletes adopted inadequate rehydration habits outside practice and as

a result they appeared in a dehydrated state for practice. Moreover, they presented high level of dehydration before the training and could not compensate it during the training despite fluid availability in the training area. In accordance with our findings, Arnaoutis et al. (2015) indicated a high prevalence of dehydration among elite young athletes from different sports during a training day and highlighted that athletes aggravated their hydration status during practice despite fluid availability. Moreover, previous studies (Osterberg, Horswill, & Baker, 2009; Palmer & Spriet 2008; Riviera-Brown & De Felix-Davila, 2012; Arnaoutis et al., 2015) noted high prevalence of dehydration in young athletes of indoor sports although they have much more opportunity to drink due to easy accession to fluids and greater number of breaks.

Dehydration is linked to many negative effects on well-being and health. It is associated with elevated arginine vasopressin (AVP). AVP travels to the kidneys via the bloodstream and help preventing excessive water loss via urination. Despite its cruciality for maintaining appropriate fluid balance, its long term consequences are hazardous. Increased level of AVP has been linked with obesity, chronic kidney disease, impaired glucose regulation and cardiovascular disease (Carroll, Betts, & Johnson, 2016; Arnaoutis et al., 2017). Moreover, it has been suggested to lead to cognitive impairments in younger populations such as memory, cognitive functions (Bar-David, Urkin, & Kozminsky, 2005; Fadda et al., 2012). Therefore, athletes should be informed about the long-term consequences of dehydration and individualized hydration protocols suggested by American College of Sport may be implemented in order to avoid health disorders.

Previous studies investigated hydration status of judo athletes during a competition day, a training camp or in humid environment (Riviera-Brown & De Félix-Dávila, 2012; Gurses et al., 2018; Stefanovsky, Clarys, Cierna, & Matejova, 2019; Ceylan et al., 2020) and they indicated high prevalence of dehydration among athletes from different levels. Ceylan et al. (2020) investigated hydration status of elite judo athletes during a competition day via USG and urine color and indicated high level of dehydration in spite of ad libitum fluid intake. Riviera-Brown and De Félix-Dávila (2012) monitored changes in hydration status of adolescent judo athletes during training in the heat and in accordance with our findings they stated that most of the athletes started and finished a training session with a significant level of dehydration and experienced symptoms of dehydration despite availability of water during training. Another study by Gurses et al. (2018) investigated acute weight gain and dehydration in judo athletes and highlighted that judo athletes could not compensate the gap of dehydration between official weigh-in and match time which was approximately 15 hours. They stated that judo athletes competed under dehydrated condition. Moreover, the findings of Stefanovsky et al. (2019) monitored hydration status of young judo athletes during a five-day training camp and the authors stated high prevalence of dehydration for the first three days.

The current study presents several limitations. First, we did not control the potential effects on USG such as prior training or supplement use, nevertheless, USG is accepted as a valid and reliable way of monitoring hydration status (Cheuvront & Sawka, 2005; Meyer et al., 2016) and its measurement before the training, especially in the morning, is more convenient for the coaches and athletes as it provides the coaches and athletes with a general idea of pre-practice hydration status, and offers some basis for comparisons for practitioners. Second, this study was primarily limited by the small number of athletes. However, the number of the samples is thought to be enough to accept the results of the study as a valid reference. Future studies are warranted to present the real effects of dehydration on judo performance at all competitive age groups.

Conclusion

In conclusion, young judo athletes presented high prevalence of dehydration during a training day. Therefore, it is very important to make young athletes gain the habit of drinking enough fluids during the day in order to arrive the practice in a euhydrated state. Young athletes must be encouraged to drink fluid often during the practice. Also, a post-training rehydration plan should be suggested based on the individual needs. It is of great importance to evaluate hydration status of the athletes before training to refrain from common practice of fluid restriction for weight loss and adverse effects of a persistent state of fluid deficit on physical and health related state.

Acknowledgements

There is no conflict of interest. We present our sincere thanks to the team and the coach.

References

Artioli, G. G., Gualano, B., Franchini, E., Scagliusi, F. B., Takesian, M., Fuchs, M., & Lancha Jr., A. H. (2010). Prevalence, magnitude, and methods of rapid weight loss among judo competitors. *Medicine and Science in Sports and Exercise, 42*(3), 436-442. DOI: https://doi.org/10.1249/MSS.0b013e3181ba8055

Armstrong, L. E., Soto, J. A. H., Hacker, F. T., Casa, D. J., Kavouras, S. A., & Maresh, C. M. (1998). Urinary indices during dehydration, exercise, and rehydration. *International Journal of Sport Nutrition and Exercise Metabolism, 8*(4), 345-355. DOI: https://doi.org/10.1123/ijsn.8.4.345

Arnaoutis, G., Kavouras, S. A., Angelopoulou, A., Skoulariki, C., Bismpikou, S., Mourtakos, S., & Sidossis, L. S. (2015). Fluid balance during training in elite young athletes of different sports. *Journal of Strength and Conditioning Research*, *29*(12), 3447. DOI: 10.1519/JSC.0000000000000400

Arnaoutis, G., Kavouras, S. A., Stratakis, N., Likka, M., Mitrakou, A., Papamichael, C., ... & Stamatelopoulos, K. (2017). The effect of hypohydration on endothelial function in young healthy adults. *European Journal of Nutrition, 56*(3), 1211-1217. DOI: https://doi.org/10.1007/s00394-016-1170-8

Baker, L. B., Conroy, D. E., & Kenney Jr, W. L. (2007a). Dehydration impairs vigilance-related attention in male basketball players. *Medicine and Science in Sports and Exercise, 39*(6), 976-983. DOI: https://doi.org/10.1097/mss.0b013e3180471ff2

Baker, L. B., Dougherty, K. A., Chow, M., & Kenney, W. L. (2007b). Progressive dehydration causes a progressive decline in basketball skill performance. *Medicine and Science in Sports and Exercise, 39*(7), 1114-1123. DOI: https://doi.org/10.1249/mss.0b013e3180574b02

Bar-David, Y. A. I. R., Urkin, J., & Kozminsky, E. L. Y. (2005). The effect of voluntary dehydration on cognitive functions of elementary school children. *Acta Paediatrica, 94*(11), 1667-1673. DOI: https://doi.org/10.1080/08035250500254670

Berkovich, B. E., Eliakim, A., Nemet, D., Stark, A. H., & Sinai, T. (2016). Rapid weight loss among adolescents participating in competitive judo. *International Journal of Sport Nutrition and Exercise Metabolism, 26*(3), 276-284. DOI: https://doi.org/10.1123/ijsnem.2015-0196

Carroll, H. A., Betts, J. A., & Johnson, L. (2016). An investigation into the relationship between plain water intake and glycated Hb (HbA1c): a sex-stratified, cross-sectional analysis of the UK National Diet and Nutrition Survey (2008-2012). *British Journal of Nutrition, 116*(10), 1770-1780.

Casa, D. J., Stearns, R. L., Lopez, R. M., Ganio, M. S., McDermott, B. P., Walker Yeargin, S., ... & Maresh, C. M. (2010). Influence of hydration on physiological function and performance during trail running in the heat. *Journal of Athletic Training, 45*(2), 147-156. DOI: https://doi.org/10.4085/1062-6050-45.2.147

Centers for Disease Control and Prevention. (1998). Hyperthermia and dehydration-related deaths associated with intentional rapid weight loss in three collegiate wrestlers—North Carolina, Wisconsin, and Michigan, November–December 1997. *MMWR Morbity and Mortalaty Weekly Report, 47*(6), 105-108.

Ceylan, B., Akgül, M. Ş., Gürses, V. V., Baydil, B., & Aydos, L. (2020) Monitoring hydration status of elite judo athletes during a competition day. *Turkish Journal of Sport and Exercise, 22*(1), 150-153.

Ceylan, B., Baydil, B., & Aydos, L. (2021). Weigh-in time affects hydration status and acute weight gain in combat sports: A comparison of judo and wrestling. *Revista de Artes Marciales Asiáticas*, *16*(2), 80-88. DOI: http://dx.doi.org/10.18002/rama.v16i2.7020

Cheuvront, S. N., & Kenefick, R. W. (2011). Dehydration: physiology, assessment, and performance effects. *Comprehensive Physiology, 4*(1), 257-285. DOI: https://doi.org/10.1002/cphy.c130017

Cheuvront, S. N., & Sawka, M. N. (2005). Hydration assessment of athletes. *Sports Sci Exchange, 18*(2), 1-6.

Cheuvront, S. N., Carter III, R., & Sawka, M. N. (2003). Fluid balance and endurance exercise performance. *Current Sports Medicine Reports, 2*(4), 202-208.

Cian, C., Barraud, P. A., Melin, B., & Raphel, C. (2001). Effects of fluid ingestion on cognitive function after heat stress or exercise-induced dehydration. *International Journal of Psychophysiology, 42*(3), 243-251. DOI: https://doi.org/10.1016/s0167-8760(01)00142-8

Cian, C., Koulmann, N., Barraud, P. A., Raphel, C., Jimenez, C., & Melin, B. (2000). Influences of variations in body hydration on cognitive function: effect of hyperhydration, heat stress, and exercise-induced dehydration. *Journal of Psychophysiology, 14*(1), 29-36. DOI: https://doi.org/10.1027/0269-8803.14.1.29

Costill, D. L., Cote, R., & Fink, W. (1976). Muscle water and electrolytes following varied levels of dehydration in man. *Journal of Applied Physiology, 40*(1), 6-11. DOI: https://doi.org/10.1152/jappl.1976.40.1.6

Detanico, D., Kons, R. L., Fukuda, D. H., & Teixeira, A. S. (2020). Physical performance in young judo athletes: influence of somatic maturation, growth, and training experience. *Research Quarterly for Exercise and Sport, 91*(3), 425-432. DOI: https://doi.org/10.1080/02701367.2019.1679334

Edwards, A. M., Mann, M. E., Marfell-Jones, M. J., Rankin, D. M., Noakes, T. D., & Shillington, D. P. (2007). Influence of moderate dehydration on soccer performance: physiological responses to 45 min of outdoor match-play and the immediate subsequent performance of sport-specific and mental concentration tests. *British Journal of Sports Medicine, 41*(6), 385-391. DOI: http://dx.doi.org/10.1136/bjsm.2006.033860

Fadda, R., Rapinett, G., Grathwohl, D., Parisi, M., Fanari, R., Calò, C. M., & Schmitt, J. (2012). Effects of drinking supplementary water at school on cognitive performance in children. *Appetite, 59*(3), 730-737. DOI: https://doi.org/10.1016/j.appet.2012.07.005

Franchini, E., Branco, B. M., Agostinho, M. F., Calmet, M., & Candau, R. (2015). Influence of linear and undulating strength periodization on physical fitness, physiological, and performance responses to simulated judo matches. *The Journal of Strength & Conditioning Research, 29*(2), 358-367. DOI: http://dx.doi.org/10.1519/JSC.0000000000000460

Ftaiti, F., Grélot, L., Coudreuse, J. M., & Nicol, C. (2001). Combined effect of heat stress, dehydration and exercise on neuromuscular function in humans. *European Journal of Applied Physiology, 84*(1-2), 87-94. DOI: http://dx.doi.org/10.1007/s004210000339

Gurses, V. V., Ceylan, B., Sakir, M., Baydil, B., Al Hussein, H., & Badau, D. (2018). Dehydration and acute weight gain of athletes before sport competitions. *Revista de Chimie, 69*(11), 4096-4098. DOI: http://dx.doi.org/10.37358/RC.18.11.6710

Hoffman, J. (2014). *Physiological aspects of sport training and performance*. Champaign, IL: Human Kinetics.

Hoffman, J. R., Stavsky, H., & Folk, B. (1995). The effect of water restriction on anaerobic power and vertical jumping height in basketball players. *International Journal of Sports Medicine, 16*(4), 214-218.

Hopkins (2019). A new view of statistics. Retrieved from: http://www.sportsci.org/resource/stats/index.html

González-Alonso, J., Mora-Rodriguez, R., Below, P. R., & Coyle, E. F. (1997). Dehydration markedly impairs cardiovascular function in hyperthermic endurance athletes during exercise. *Journal of Applied Physiology, 82*(4), 1229-1236.

Judelson, D. A., Maresh, C. M., Anderson, J. M., Armstrong, L. E., Casa, D. J., Kraemer, W. J., & Volek, J. S. (2007). Hydration and muscular performance. *Sports Medicine, 37*(10), 907-921.

Kavouras, S. A. (2002). Assessing hydration status. *Current Opinion in Clinical Nutrition & Metabolic Care, 5*(5), 519-524.

Meyer, F., Szygula, Z., & Wilk, B. (2016). *Fluid balance, hydration, and athletic performance*. Boca Raton, FL: CRC Press.

Osterberg, K. L., Horswill, C. A., & Baker, L. B. (2009). Pregame urine specific gravity and fluid intake by National Basketball Association players during competition. *Journal of Athletic Training, 44*(1), 53-57. DOI: https://doi.org/10.4085/1062-6050-44.1.53

Palmer, M. S., & Spriet, L. L. (2008). Sweat rate, salt loss, and fluid intake during an intense on-ice practice in elite Canadian male junior hockey players. *Applied Physiology, Nutrition, and Metabolism, 33*(2), 263-271. DOI: https://doi.org/10.1139/H08-011

Pettersson, S., & Berg, C. M. (2014). Hydration status in elite wrestlers, judokas, boxers, and taekwondo athletes on competition day. *International Journal of Sport Nutrition and Exercise Metabolism, 24*(3), 267-275.

Popowski, L. A., Oppliger, R. A., Lambert, G. P., Johnson, R. F., Johnson, A. K., & Gisolfi, C. V. (2001). Blood and urinary measures of hydration status during progressive acute dehydration. *Medicine and Science in Sports and Exercise, 33*(5), 747-753.

Rivera-Brown, A. M., & De Félix-Dávila, R. A. (2012). Hydration status in adolescent judo athletes before and after training in the heat. *International journal of Sports Physiology and Performance, 7*(1), 39-46. DOI: https://doi.org/10.1123/ijspp.7.1.39

Sawka, M. N., Burke, L. M., Eichner, E. R., Maughan, R. J., Montain, S. J., & Stachenfeld, N. S. (2007). American College of Sports Medicine position stand. Exercise and fluid replacement. *Medicine and Science in Sports and Exercise, 39*(2), 377-390.

Scott, J. R., Horswill, C. A., & Dick, R. W. (1994). Acute weight gain in collegiate wrestlers following a tournament weigh-in. *Medicine and Science in Sports and Exercise, 26*(9), 1181-1185.

Stefanovsky, M., Clarys, P., Cierna, D., & Matejova, L. (2019). Hydration status of youth Judo athletes during an off-season training camp. *Ido Movement for Culture. Journal of Martial Arts Anthropology, 19*(3), 56-62. DOI: http://dx.doi.org/10.14589/ido.19.3.7

Torres-Luque, G., Hernández-García, R., Escobar-Molina, R., Garatachea, N., & Nikolaidis, P. T. (2016). Physical and physiological characteristics of judo athletes: an update. *Sports, 4*(1), 20. DOI: https://doi.org/10.3390/sports4010020