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Hydration status of youth Judo athletes during an off-season training camp

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Key words: urine specific gravity, judo, hypohydration, dehydration

Abstract

Problem and Aim. There is a lack of scientific literature about hydration status changes of combat athletes during different periods over a one-year training cycle. The aim of this study is to evaluate the hydration status in youth judo athletes during an off-season 5-day judo training camp.

Methods. The research sample was composed of six judo athletes, age 16 (IqR=3.25), body weight 81 (IqR=18.75) kg, height 179 (IqR=6.5) cm, sports age 9.5 (IqR=3.5). Morning urine samples in test-tubes were collected from athletes´ rooms and analysed using a digital refractometer ATAGO PAL-10S for urine specific gravity (U_{SG}). The data was analysed using a non-parametric ANOVA for repeated measures (Friedman´s ANOVA) with the calculation of effect size (Kendall´s Coefficient of Concordance). The results were expressed as a median (Med) with interquartile range (IqR). The statistical significance was set at $p<0.05$.

Results. After the first morning measurement, the participants were hypohydrated U_{SG}=1.0235 (IqR=0.0100). Next day the participants were still hypohydrated U_{SG} =1.0259 (IqR=0.0154) and the values were even worse than the previous day. The U_{SG} values tended to improve on the 4th day U_{SG}=1.0195 (IqR=0.0100) and 5th day as well U_{SG}=1.0177 (IqR = 0.0100) and athletes were only minimally hypohydrated. However, there was no significant difference between all measurements (p=0.334) and the effect size was small (Kendall´s W =0.189).

Conclusions. Even though judo athletes trained off-season when body weight reduction was not necessary their hydration status was still suboptimal.

Background, Problem, and Aim

A judo match lasts 4 min and has intermittent character, with a section of load between 10 – 30 seconds and with breaks of 5–10 seconds. The technical complex of judo consists of standing techniques (grips, throws, and takedowns) and ground-work techniques (pinning, strangles and joint locks). To reach the medal podium at the top-level judo competitions, the fighters usually must win 4 to 6 contests per day. Judo athletes are divided into 7 weight categories. A typical somatotype among judo male contestants is endomorphic mesomorph, with dominant mesomorphy and endomorphy greater than ectomorphy [Sterkowicz-Przybycien *et al.* 2012]. During the competition season, judo players often attempt to maximize lean tissue mass, minimize body fat, and minimize total bodyweight [Franchini *et al.* 2011]. Some judo athletes, especially in light-weight categories, typically have 5 – 8 % of subcutaneous fat [Stefanovsky 2015]. The latest scientific findings in judo and other combat sports with weight categories, point out the frequent usage of the rapid bodyweight reduction in an aggressive and harmful way [Grann *et al.* 2015; Brito *et al.* 2012; Artioli *et al.* 2010]. To achieve a reduction in weight, athletes use a variety of methods that lead to intentional hypohydration, or starvation. These methods may include long periods of fasting, exercising in plastic/rubber suits, saunas and severe restriction of fluid intake [Artioli *et al.* 2016], which can lead to dehydration.

Dehydration is commonly defined as the dynamic loss of body water due to sweating over the course of

exercise without fluid replacement or a process during which fluid replacement is inadequate [Zubac *et al.* 2015; Sawka *et al.* 2007]. Hypohydration refers to a state or level of hydration after a loss of a certain amount of body water [Zubac *et al.* 2018; Cheung 2010].

Several studies have investigated fluid balance and hydration status in Olympic boxing [Zubac *et al.* 2016], mixed martial arts [Jetton *et al.* 2013], wrestling [Loenneke *et al.* 2011] and other combat sports. The results showed that fluid balance is often negative and leads to hypohydration or severe hypohydration. Existing field-based research for example in adult soccer players reports large variations in sweat rate and sweat losses between players [Shirreffs *et al.* 2006], and incidences of soccer players, judo players and other combat sports athletes beginning training or competing in a hypohydrated state [Rivera-Brown, De Felix-Davila 2012; Jung, Malliaropoulos 2014; Pettersson, Berg 2014; Zubac *et al.* 2018; Maughan *et al.* 2005]. Body water and electrolyte balance are critical for normal cellular function and keeping proper blood and plasma volume and osmolality. Dehydration or excess body water loss has negative physiological consequences that impair performance and can be hazardous to one's health. These adverse effects include impaired glycogen use, central nervous system dysfunction, increases in core temperature and cardiovascular strain [Jetton *et al.* 2013]. Regarding exercise performance issues, studies have demonstrated that relatively moderate degrees of hypohydration, i.e., -1 to -3% of body mass, affect performance adversely [Maughan 2003]. According to El Ghoch *et al.* [2013]; Bratland-Sanda, Sundgot-Borgen [2013] and Rivera-Brown, De Felix-Davila [2012] dehydrated athletes may show decreased work capacity, reduced muscle strength, reduced bone mineral density and impaired athletic and cognitive performance. A body water loss of as little as 2% of body weight can compromise cardiorespiratory endurance and muscular function, which can affect performance in judo. Dehydrated athletes usually reported symptoms such as thirst, dizziness, fatigue, headache, muscle cramps, and mood changes. Other evidence suggests that a dehydration of 3 to 4% of initial body weight may result in a decrease in muscle strength by about 2%, muscle power by approximately 3%, and endurance in high-intensity activities lasting more than 30 s but less than 2 min by approximately 10% [Judelson *et al.* 2007].

The magnitude of fluid loss depends on a variety of factors such as training characteristics, climate conditions (temperature and humidity), level of fitness of the population and whether liquids are offered during training or not [Hayakawa *et al.* 2018].

Studies by Silva *et al.* [2011] and Phillips *et al.* [2014] followed elite male soccer players during three training sessions spread over three consecutive days using urine specific gravity measurement (U_{SG}) to assess the hydration status. Both studies found that more than half of the players were at least minimally hypohydrated at the start of each training session. Gibson *et al.* [2012] found similar results in female soccer players, where 41% of the young females started their training in a hypohydrated state and 4.5% in a severely hypohydrated state.

Hydration assessment techniques using blood samples, based on plasma osmolality and hematocrit are very accurate methods, although they may be less suited for field studies, being expensive and requiring a high level of expertise. Urine specific gravity (U_{SG}) is recognized to be a reliable and practical method to assess the hydration status [Armstrong *et al.* 1998]. Hydration status can be estimated by analysing the first urine excretion of the day as urine concentration in this sample is sufficiently sensitive to detect deviations in fluid balance [Phillips *et al.* 2014; Sawka *et al.* 2007; Shirreffs, Maughan 1998].

Studies mentioned above usually track the hydration status of athletes in pre- and post-training periods, or in pre-competition, or pre- and post-weigh-in periods. None of the studies has been conducted in an off-season period. Therefore, the aim of this pilot study was to evaluate the hydration status in youth judo players during a 5-day off-season training camp.

Methods

Participants

Six young male judo players volunteered for this study, all of whom were members of Judo club Slavia STU Bratislava. The characteristics of the participants were as follows: age 16 (IqR=3.25) years, body weight 81 (IqR=18.75) kg, height 179 (IqR=6.5) cm, sports age 9.5 (IqR=3.5) years, technical level 2nd and 1st kyu. All of them were at the national level and have trained judo during the season at least 3 – 5 days a week. None of the athletes were engaged in any weight-loss procedure during the training camp. Prior to inclusion, a written explanation of the study was provided to participants and parents. Legal guardians signed an informed consent agreement form. The study design received ethical approval (Nr. 5/2018) from the local Ethics Committee.

Procedure

The training camp took place in Cadca, Slovakia from 9th to 13th July 2018. It started on Monday at 12.00 and finished on Friday at 18.00. The body weight (using body scale Topcom 500 made in Belgium, with the precision of the instrument up to 100 g), and heights were measured at the beginning of the camp, before the first-afternoon training session. The urine samples were taken totally four times and analyzed for urine specific gravity (U_{SG}) using a digital refractometer ATAGO PAL-10S (made in Tokyo, Japan). The device was calibrated according to manufacturer instructions. According to the rec-

ommendations of Zubac *et al.* [2018], a sample of the mid-flow urine upon waking was collected from each athlete every morning (around 6.30 – 6.50 o'clock). A U_{SG} value of less than 1.010 g.ml indicates euhydration whilst a value between 1.010 and 1.019 g.ml illustrates minimal hypohydration. A U_{SG} value exceeding 1.020 g.ml may indicate hypohydration and a value exceeding 1.030 g.ml is indicative of a severely hypohydrated state [Chapelle *et al.* 2017]. Participants consumed water *ad libitum* during the whole training camp. Drinking water was available in a 15l container at the side of the training pitch and judo mat for each training session. The participants had the opportunity to consume fluid (clean water) during the short breaks, or when training instructions were being provided by the coach. Average ambient temperature on 1st day was 28 °C, 2nd day 25 °C, 3rd day 19 °C, 4th day 23 °C and 5th day 23 °C.

Training sessions

Except for the first day, (table 1) three training sessions per day were conducted. Morning sessions, from 09.30 to 11.00 o'clock, were judo technical-tactical training, mainly focused on grip fighting, throwing, ground-work and transitions from standing to ground-work fight. There were no randori fights during the whole training camp. Afternoon sessions, from 15.00 to 16.30, were strength & conditioning training, with a focus on the proper technique of weight lifting and injury prevention with a strength and condition specialist. Evening sessions, from 17.00 to 18.00, were focused on energetic system development (ESD) through the non-specific exercises (soccer and Frisbee).

Statistical analysis

Data analysis was undertaken using Statistical Package for the Social Sciences (SPSS, version 20 for Windows, IBM, Armonk, NY, United States). The data were analysed using a non-parametric ANOVA for repeated measures (Friedman´s ANOVA) with the appropriate calculation of effect size (Kendall´s Coefficient of Concordance). The effect size for Friedman´s test was calculated and defined as small (W=0.1), medium (W=0.3), and large (W=0.5). The results were expressed as a median with interquartile range. Statistical significance was set at $p<0.05$.

Results

After the first morning measurement (figure 1) the participants were hypohydrated U_{SG}= 1.0235 $g.ml^{-1}$ (IqR=0.0100). On the 3rd day, the participants were still hypohydrated U_{SG}=1.0259 $g.ml^{-1}$ (IqR=0.0154) and the values were worse than the previous day. The hydration status improved on 4th day U_{SG}=1.0195 $g.ml^{-1}$

Table 1. Characterisation of the training sessions

Session	Task performed	Volume	Intensity
1 - Monday	Foam rolling, dynamic stretching and joint mobilization (educational session)	90 min	low
2 - Monday	ESD - Soccer	60 min	moderate and high
3 - Tuesday	Judo - grip fighting (taking and breaking)	90 min	low, moderate, high
4 - Tuesday	Strength & conditioning (kettlebell educational session)	90 min	low and moderate
5 - Tuesday	ESD - Frisbee	60 min	moderate and high
6 - Wednesday	Team building activities	120 min	low and moderate
7 - Wednesday	Aqua park	120 min	low
8 - Thursday	Judo – ground work and transition techniques into ne-waza	90 min	moderate and high
9 - Thursday	Foam rolling, dynamic stretching joint mobilization and compensation	90 min	low and moderate
10 - Thursday	ESD - Frisbee and Soccer	60 min	moderate and high
11 - Friday	Judo chains (grip+throw+transition into ground work)	90 min	moderate and high
12 - Friday	Strength & conditioning (circuit training)	90 min	moderate and high
13 - Friday	ESD - Frisbee and Soccer	60 min	moderate and high

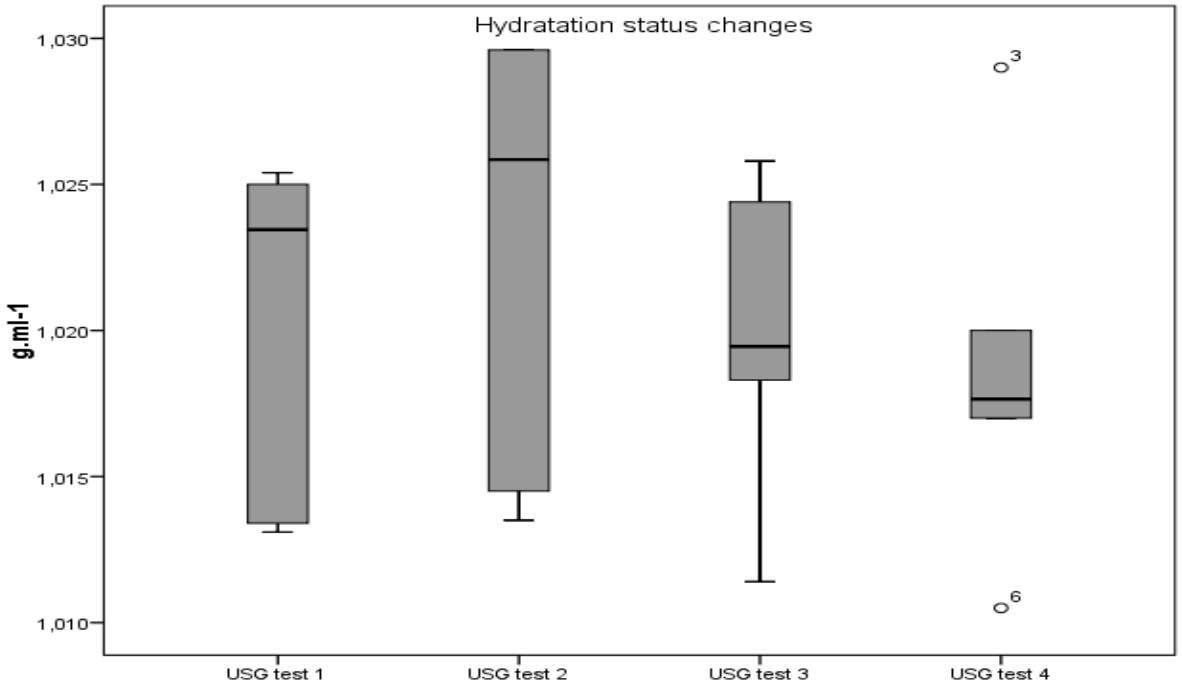

Figure 1. U_{SG} status during the training camp. U_{SG} test 1 – day 2, U_{SG} test 2 – day 3, U_{SG} test 3 – day 4, U_{SG} test 4 – day 5. Friedman ANOVA = 0.334, Kendall´s coefficient of concordance = 0.189.

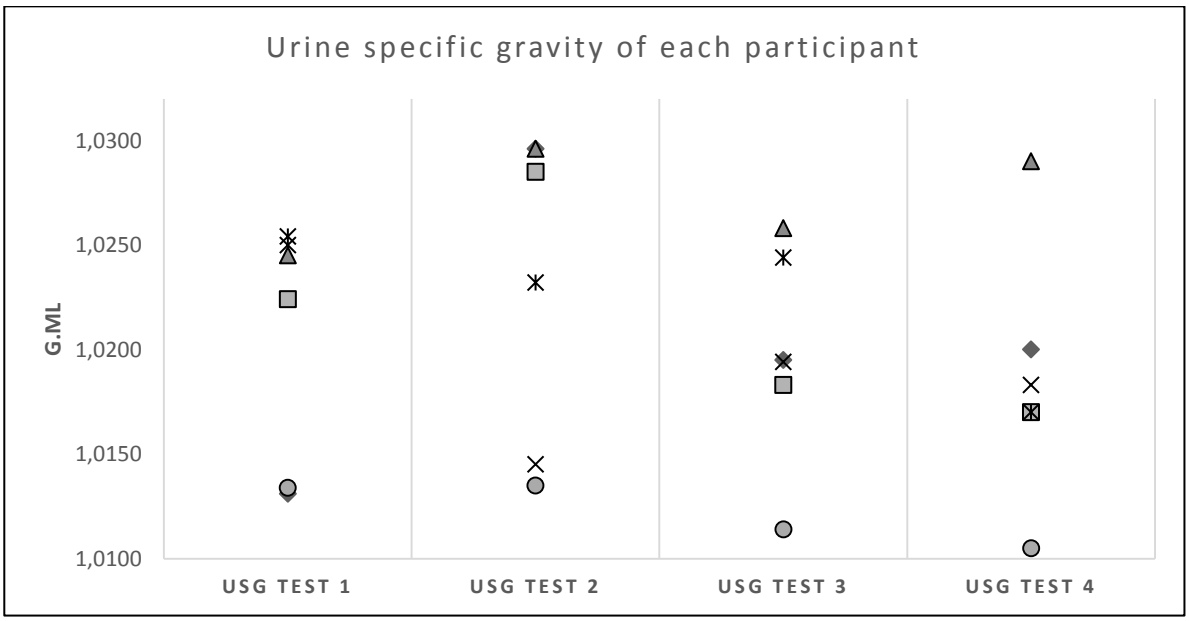

Figure 2. The U_{SG} individual values of every participant. A U_{SG} value between 1.010 - 1.019 g.ml illustrates minimal hypohydration; a U_{SG} value between 1.020 g.ml – 1.029 g.ml indicates hypohydration.

(IqR=0.0100) and 5th day U_{SG}=1.0177 g.ml^{-1} (IqR = 0.0100) as well, and the athletes were only minimally hypohydrated. However, there was no statistical difference between all measurements (p=0.334) and the effect size was small (Kendall´s W =0.189).

After the first measurement, two participants were minimally hypohydrated and four were hypohydrated (figure 2). U_{SG} test2 indicates hydration worsening, three participants were nearly below the borderline of severe hypohydration, one was hypohydrated, and two participants were minimally hypohydrated. On the next day, U_{SG} test3 indicates hypohydration of two athletes and four athletes were below the value <1.200 g.ml^{-1}, which indicates only minimal hypohydration. U_{SG} test4 shows that one athlete (1.0290 g.ml^{-1}) is right below the borderline of severer hypohydration. This athlete was hypohydrated during the whole training camp and has reached the worst individual values (1.0245, 1.0296, 1.0258, 1.0290 g.ml^{-1}). Other athletes were on the last day of the camp only minimally hypohydrated.

Discussion

This pilot study, evaluating the hydration status of judo athletes during an off-season training camp indicates that hydration in these young athletes is not optimal. Off-season judo training is mainly focused on physical and mental recovery after a previous competition season. Another aim is to build the whole new judo technical and tactical complex, and/or to develop energetic systems by using a variety of non-specific exercises. Even in a period where less attention needs to be paid to weight reduction – often performed by aggressive dehydration procedures – judo athletes are not optimally hydrated. In the case study conducted on one MMA athlete Kasper *et al*. [2018] demonstrated that excessive dehydration induced a significant stress response (3-fold increases in plasma cortisol to approximately 1500 nmol.L^{-1}) and is evidenced by the elevations in serum proteins, plasma osmolality and sodium concentration to 148 mmol.L^{-1} near to the severe levels of hypernatremia. The increases in plasma sodium observed in this study were near to the severe levels of hypernatremia (>150 mmol.L^{-1}) where mortality may occur [Darmon *et al.* 2010].

The insufficient hydration status by the young judo athletes in the present study may have been caused by poor previous education about the importance of fluid intake during the training process and recovery periods, by using judo-gis that reduce the dissipation of heat into the environment during the judo practices, or as a combination of both factors. According to Chapelle *et al.* [2017], the hydration status of the athlete can be corrected by giving the athlete personalized advice on how to rehydrate properly. The prospects of an information session or individual guidance to help players achieve a euhydrated state look promising. Although the effects seem to be short-lasting.

The use of thirst sensation as a strategy to promote adequate fluid intake during judo training was tested in two sessions of training [Hakayama *et al.* 2018]. Athletes were oriented to ingest water or a sports drink just when they felt thirsty. There was a reduction in the fluid intake when a fluid replacement was guided by thirst alone in the case of both beverages (water and sports drink). When the beverage offered was the sports drink this reduction was drastic (593.3 mL without thirst sensation vs 152.2 mL with thirst sensation). The authors conclude that judo athletes in tropical regions are susceptible to dehydration due to the common practice of fluid restriction during the training, environmental conditions, and the use of a judo-gi (training uniform) that reduces the dissipation of heat to the environment.

Rehydration is an essential part of the recovery process because the intracellular fluid volume loss is reported to impair the glycogen and protein resynthesis rate [Chapelle *et al.* 2017; Waller *et al.* 2009; Keller *et al.* 2003]. Sufficient fluid intake and other hydration strategies help optimize recovery on rest days or between consecutive training sessions [Chapelle *et al.* 2017]. Athletes often do not understand the purpose of proper rehydration or are careless towards their own recovery, which seems to be one of the important factors leading to poor recovery, competition performance or health problems. A post-exercise fluid replacement plan is important to correct the hypohydration state of young athletes when they finish their training sessions and ensure that they start the next training session in an adequate state of hydration. The athletes should monitor their body weight before and after the training session in combination with fluid intake to rehydrate optimally. Guidelines suggest that athletes should consume 125 to 150% of the fluid deficit after exercise and that the fluid replacement drink should contain a sodium concentration of 50–100 mmol/L [Rosseneu, Swartz, 2017; Casa *et al.* 2005].

An interesting finding in our study was that the heaviest person was the most hypohydrated athlete during the whole camp. One cross-sectional study [Zubac *et al.* 2016] demonstrated that there were differences in hydration status between the super-heavyweights and other weight class categories in youth boxers, whereas the low- and middle-weight boxers had urine concentration readings that were uniform, only the super heavyweight boxers did not. Authors concluded that body mass may have an influence on fluid changes in combat sports athletes.

The results of our study must be interpreted with caution because the assessment of hydration status via U_{SG} can be influenced by various confounding factors. Intense training and protein breakdown may interfere with the diagnostic accuracy of U_{SG}. Proteins and other larger molecules which pass into the urine increase urine density [Voinescu *et al.* 2002]. Greater impact and severity of mechanical trauma was associated with an increased presence of protein and red blood cells; thus, it is not unreasonable to suggest this phenomenon would occur in other combat sports where contact is common [Zubac *et al.* 2018]. Another limitation of this study is, we did not measure the amount of consumed water during the training sessions.

Future research should focus on U_{SG} measurements during different training camps and periods in combination with estimates of body composition. The addition of modern multi-frequency bioimpedance analysis may study the water content in different body compartments (e.g. extra versus intracellular water). The latter method may also bring information on fat and muscle mass changes in relation to training and hydration status which is extremely important for sports with weight categories.

During the off-season training camps, athletes should be educated about optimal recovery, fluid intake, restoration of fluid balance and optimal weight reduction strategies.

Conclusion

The hydration status should be monitored throughout the season and off-season camps as well, as this study found that hydration of young judo players is considered to be suboptimal. Judokas and their coaches should pay more attention to sufficient fluid intake throughout the whole season in order to optimize training, performance, recovery and athlete´s overall health.

Digital refractometer provides quick information about hydration status. Body mass may have an influence on fluid changes in combat sports athletes.

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Status hydratacji młodych zawodników judo podczas pozasezonowego obozu treningowego

Słowa kluczowe: ciężar właściwy moczu, judo, hipohydracja, odwodnienie

Abstrakt

Problem i cel. Brak jest literatury naukowej na temat zmian statusu hydratacji zawodników sportów walki w różnych okresach w ciągu rocznego cyklu treningowego. Celem badania była ocena stanu nawodnienia u młodych zawodników judo podczas 5-dniowego obozu treningowego poza sezonem.

Metody. W badaniu brało udział sześciu judoków, w wieku 16 (IqR=3,25) lat, o masie ciała 81 (IqR=18,75) kg, wzroście 179 (IqR=6,5) cm i czasie trenowania 9,5 (IqR=3,5). Pobrane z pokoi sportowców poranne próbki moczu zanalizowano w probówkach przy użyciu cyfrowego refraktometru ATAGO PAL-10S w celu określenia ciężaru właściwego moczu (U_{SG}). Dane analizowano przy użyciu nieparametrycznej analizy ANOVA dla powtarzalnych pomiarów (ANOVA Friedmana) z obliczeniem wielkości rezultatu (Współczynnik Zgodności Kendalla). Wyniki wyrażono, jako medianę (Med) z przedziałem międzykwartylowym (IqR). Istotność statystyczną ustalono na poziomie $p<0,05$.

Wyniki. Po pierwszym pomiarze porannym, uczestnicy zostali poddani hipohydratacji U_{SG}=1,0235 (IqR=0,0100). Następnego dnia uczestnicy nadal byli hipohydratowani U_{SG} = 1,0259 (IqR=0,0154), a wartości były jeszcze gorsze niż w dniu poprzednim. Wartości U_{SG} poprawiały się 4 dnia $U_{SG=}$ 1,0195 (IqR=0,0100) i 5 dnia oraz U_{SG}=1,0177 (IqR = 0,0100), a sportowcy byli tylko minimalnie hypohydrowani. Nie stwierdzono jednak istotnej różnicy między wszystkimi pomiarami (p=0,334), a wartość wyniku była mała (W =0,189 Kendalla).

Wnioski. Mimo, że zawodnicy judo trenowali poza sezonem, kiedy redukcja masy ciała nie była konieczna, ich stan nawodnienia nadal nie był optymalny.