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Original Article

Could weigh-in procedures that are held close to the commencement of the fight cause hypo-hydration of karate athletes?

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Abstract
Background: Martial Arts athletes compete in various weight categories and they manage body weight regularly during the course of the year to gain an advantage over an opponent. The bodyweight reduction can be gradual or rapid. Rapid weight loss is used more often by athletes. A common athlete´s behavior during rapid weight loss is starvation or a fluid intake reduction, which can easily lead to hypohydration. **Purpose:** The aim of the study was to evaluate the hydration status of young karate athletes close to the beginning of the performance at the Slovak National Karate Championships. **Material and Methods:** The sample consisted of 10 young top-level male kumite karate athletes: age (*M*=16.9, *SD* =1.57 years), body height (*M*=17.6, *SD*=2.8 cm), body weight (*M*=62.14, *SD*=6.83 kg), sports practice (*M*=9.7, *SD*=2.11 years), BMI (*M*=20.47, *SD*=2.35). Athletes have been measured by Tanita bio impedance scale and urine specific gravity (U_{SG}) was assessed by Atago refractometer before their fights. **Results:** According to median values of the whole observed sample, karate athletes were hypo-hydrated before their fights commenced, *Mdn* = 1.021 $g.ml^{-1}$ (z = -2.805, p = .005, r = .887). The individual values showed that two athletes were severally hypohydrated, four were hypohydrated, only four athletes were hypohydrated minimally. **Conclusions:** Karateka tend to deepen their hypo-hydration before the competition. We recommend that karate athletes drink enough liquids before the competition and avoid lowering the body weight by reducing fluid intake. This will prevent inauspicious events that may negatively affect their performance and prolong the regeneration process. The athletes should be educated about the importance of proper hydration to be able to protect their long-term health.
Keywords: kumite, hydration, specific urine gravity

Introduction

Since the announcement that karate will make its debut appearance at the Summer Olympic Games in 2020 in Tokyo, Japan [WKF News Center 2018], there has been an increase in the number of athletes participating in top-level karate tournaments [WKF News Center, 2018]. The WKF (World Karate Federation) is recognized by the International Olympic Committee as the international governing body for Olympic-style karate. The WKF has more than 150 member countries and hosts the World Karate Championships bi-annually, and the Continental Championships annually. In WKF kumite competition, athletes are divided by gender, age (cadets 14–15, juniors 16-17, U21 18-20, seniors 18 + years old) and by weight categories (with weight differences approximately 5 to 9 kg depending on their category). During WKF karate competition, the weigh-in procedure is the same for all age categories.

Before the official weigh-in, athletes can check their weight on the official weigh-in scales. There is no limit to the number of times an athlete can check their weight. During WKF competition the weigh-in must take place, at the latest, the day before the day of competition for their category (usually at nine o´clock a.m.) [World Karate Federation 2019]. Athletes than have some time to apply sufficient diet and fluid intake after weigh-in procedures up to competition to avoid a performance loss, called rebound effect [Iniesta et al. 2017]. During Slovak National Karate Championships, the weigh-in takes place before the fight (approximately 5 minutes before the start of the fight). An athlete that does not turn up for the weigh-in period or fails to weigh in within the prescribed limits for the category in which the athlete is registered, will be disqualified. The tolerance admitted for any category is 0.200 kg [Slovensky zvaz karate 2017].

To achieve an advantage over an opponent, athletes often attempt to maximize lean muscle tissue mass, minimize body fat, and optimize total body weight during the competition season [Franchini et al. 2011]. Youth top-level karate athletes can compete at Youth League Tournaments, one continental, and a minimum of one national championship, so they need to keep their weight constant during whole competition season [WKF News Center 2019]. This might be especially difficult since the tournaments are spread throughout the whole year.

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The latest scientific researches in other combat sports with weight categories pointed out the frequent usage of the rapid body-weight reduction in an aggressive and harmful way [Artioli et al. 2010; Brito et al. 2012; Gann et al. 2015]. To achieve a reduction in weight, athletes use a variety of methods that lead to intentional hypo-hydration 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 and other negative consequences. The prevalence of rapid weight loss, more than 5% of body mass, is highest in Judo (43.4%) and lower in Jujitsu (27.1%), Karate (29.2%) and Taekwondo (28.7%) [Brito et al. 2012]. Also, MMA competitors often undergo weight loss procedures [Santos Jr. et al. 2019]. Authors concluded that all of 179 Brazilian professional MMA fighters in their study (164 males and 15 females) at least once underwent harmful and illegal methods, such as gradual diet, fluid intake restrictions and sweat suits, also using diuretics and laxatives, losing up to 10% body mass, with no differences between weight classes or genders. Although international level athletes demonstrated even more aggressive weight management behaviour.

Dehydration is commonly defined as the dynamic loss of body fluid due to sweating throughout exercise without fluid replacement, or a process during which fluid replacement is inadequate [Zubac et al. 2015]. Hypo-hydration refers to a state or level of hydration after a loss of a certain amount of body fluid [Zubac et al. 2018].

Dehydration, or excess body fluid loss, has negative cognitive, physical, physiological effects that impair performance and can also be hazardous to ones' health [Iniesta et al. 2017].

Dehydration, or excess body fluid loss, has negative physiological effects that impair performance and can also be hazardous to ones' health. These adverse effects include impaired glycogen use, central nervous system disfunction, increase in core temperature, and cardiovascular strain [Jetton et al. 2013]. For this reason, weight loss practices must be restrained to perform high-level athletic performance.

The hydration status can be measured using different methods: blood samples, urine osmolality, urine colour, urine specific gravity, or body weight. Urine specific gravity (USG) is recognised to be a valid [Armstrong 2005; Popowski et al. 2001] and reliable and practical method to assess the hydration status [Armstrong et al. 1998]. This technique studies the density (ratio of mass to volume) of a urine sample compared to water density [Iniesta et al. 2017]. USG is highly associated with urine osmolality (UOSM) whilst being accessible, and easy to use, technique. Urine colour (UCOL) is a suitable tool when USG is not available [Fernandez-Elias et al. 2014].

The different duration between weigh-in procedures and competition also leads to differences in the level of weight loss and dehydration of athletes in combat sports. Therefore, shortening the duration between weigh-in procedures and competition may result in minimized weight loss and dehydration status at the same time. For this reason, the UWW (United World Wrestling) introduced a new weigh-in rule (time between weight-in and competition reduced from 18 to 2 hours) that caused wrestlers to reduce their amount of body weight loss. Despite that, the athletes regained their lost body weight, and U_{SG} levels decreased, it remained above the reference range [Güder2020]. Other authors have reported that dehydration in athletes of different combat sports associated with weight loss between weigh-in and competition persists, despite regaining the body weight after weigh-in procedures for both, shorter and longer intervals [Gürses et al. 2018; Pettersson and Berg 2013]. Even more time for rehydration seems not to prevent hypohydration before the competition.

Actual studies focusing on the hydration of athletes were conducted under no competition conditions, out of the competition season, 24 hours before the competition [Jetton et al. 2013], or before, during, and after the competition [Gibson et al. 2012; Maughan et al. 2005; Rivera-Brown et al. 2012; Shirreffs et al. 2004].

The aim of the study was to evaluate the hydration of young karate athletes close to the commencement of the fight.

Materials and methods

Study design

The data was collected under standard circumstances, in a private changing room with the sanitary facility (room temperature was 25°C). Measuring was conducted before the warm-up, closely before the start of the performance. The official weighing was held closely before the competitors´ matches (Figure 1).

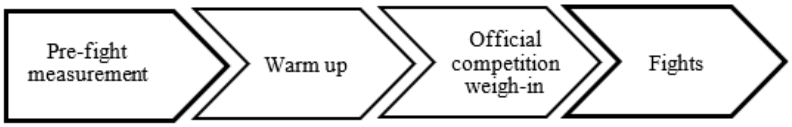

Fig.1 Organization of the study

Somatic parameters were collected by the bioimpedance scale Tanita DS-601, and hydration of the athletes was gauged by urinary refractometer Atago PAL-10S. Both procedures were identical. The hydration was assessed with reference values in a three-degree scale [Chapelle *et al.* 2017]: a Urinary specific gravity (U_{SG}) value of less than 1.010 $g.ml^{-1}$ indicates euhydration whilst a value between 1.010 and 1.019 $g.ml^{-1}$ illustrates minimal hypo-hydration. A U_{SG} value exceeding 1.020 $g.ml^{-1}$may indicate ~~s~~ hypo-hydration, and a value exceeding 1.030 $g.ml^{-1}$ is indicative of a severely hypo-hydrated state.

Before testing we asked about the sport age, eating, and liquids intake behaviour before the competition. When measuring somatic parameters, the athletes wore no upper part of their karate-gi, only the trousers, according to standards [Gligoroska *et al.* 2018]. After the weigh-in, the athletes allowed us to take a midstream urine sample, which we assessed directly afterwards.

Subjects

The sample consisted of 10 young top-level karate athletes: age (M=16.9, SD =1.57 years), body height (M=17.6, SD=2.8 cm), body weight (M=62.14, SD=6.83 kg), sport practice (M=9.7, SD=2.11 years), BMI (M=20.47, SD=2.35). All of them were members of Slovak National Karate Team and were in the selection period for European Karate Championships for Cadets, Juniors & U21. The inclusion criteria for subjects who were to compete in the minus weight division means that the subjects had to manage their actual body weight (lose weight).

Statistical analysis

The statistical analyses were carried out using the SPSS 21.0 program for Windows (SPSS, Inc., Chicago, IL, USA). Data's normality was checked through the Shapiro-Wilk test. For comparison of non-parametric data (U_{SG}, bodyweight, etc.) the Wilcoxon signed-rank test was conducted. Effect sizes (Cohen's r) were calculated using standard formula for non-parametric tests using the following scale for interpretation: $r \geq 0.5$ (large effect), $r \geq 0.3$ and < 0.5 (medium effect), and $r < 0.3$ (small effect) [Fritz et al. 2012]. The significance level of $p < 0.05$ was used.

Ethical considerations

This study was approved by the Ethics Committee of the Faculty of Physical Education and Sports, Comenius University, Bratislava, Slovakia (reference number 05/2018). Before the research began the volunteers signed an informed consent form.

Results

Comparing U_{SG} measured right before sport performance with reference values, our results found karate athletes hypo-hydrated close to the commencement of their fights, *Mdn* = 1.021 g.ml^{-1} (z = -2.805, p = .005, r = .887), as shown in Figure 2.

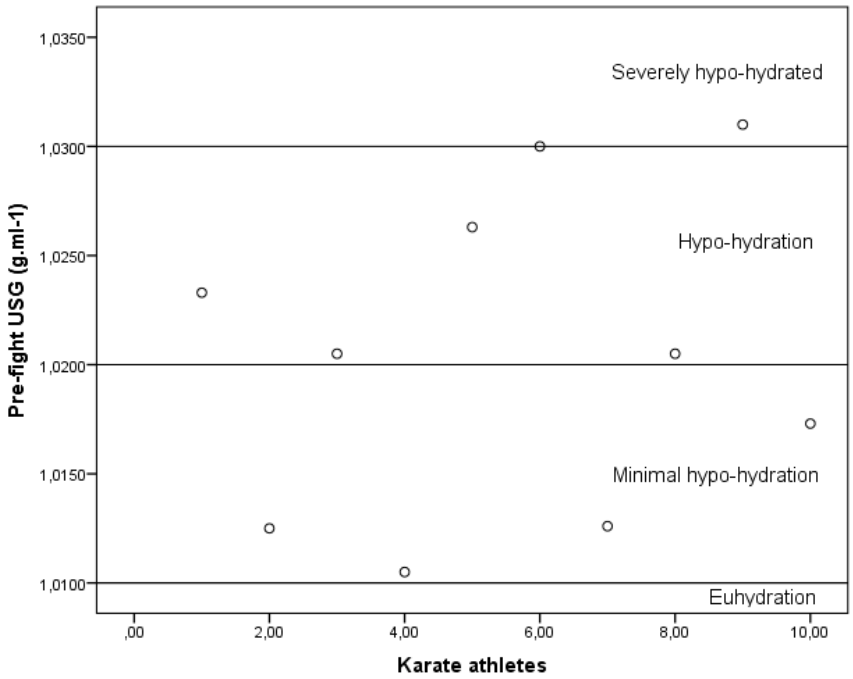

Fig.2 Individual pre-fight U_{SG} (g.ml^{-1}) values

Discussion

Young karate athletes were minimally hypo-hydrated before their fights at the Slovak National Championships (*Mdn* = 1.021), but two of them were severely hypo-hydrated. The same degree was reported by Jetton *et al.* [2013]. Adult MMA fighters were equally de-hydrated 24 hours before the competition. It is obvious that young karate athletes copy the behaviour of older ones. They were hypo-hydrated in disregard of competing or training in hot conditions [Rivera-Brown *et al.* 2012] or cool environment [Gibson *et al*., 2012; Maughan *et al*., 2005]. During WKF events the weigh-in procedure is held one day before the competition. One day for re-hydration lowers the dehydration but is not long enough to ensure full recovery [Jetton *et al.* 2013]. The Slovak

Karate Championships is a specific event because the athletes' weigh-in procedure is held directly before the start of their first fight.

The exclusion of liquids before the competition could negatively affect their physical performance. As was the case of an MMA athlete who was trying to reduce his body weight before the competition and was unable to complete performance tests [Kasper *et al.* 2018]. Hypo-hydration decreases physical performance [Von Duvillard *et al.* 2008] and has an effect on the endocrine system, and levels of testosterone.

There is also an association between water intake and cognitive control using a task that modulates inhibition. Specifically, higher water intake correlated with greater ability to maintain task performance when inhibitory demands are increased [Khan *et al.* 2015] is essential during a karate fight. College athletes showed better vigilance attention with euhydration [D'anci *et al.* 2009].

Proper hydration before, during, and after training and competition, will help reduce fluid loss, maintain performance, lower submaximal exercise heart rate, maintain plasma volume, and reduce heat stress, heat exhaustion, and possible heat stroke [Von Duvillard *et al.* 2008]. This could be harmful if this approach to lowering the weight is done rapidly, and multiple times per year, especially in wrestlers every week during the season [Kiningham *et al.* 2001].

McArdle *et. al* [2014] and Rico-Sanz et al. [1996] recommend drinking approximately 500 ml of water, the night before sports performance in a hot environment, an additional 500 ml in the morning after waking up, and approximately 400 to 600 ml of water about 20 min before performance. e.g. an increased fluid intake regime (4.5 l per day) 1 week prior to the elite football tournament led to an increase in body water supply and improved thermoregulation during a match [Rico-Sanz et al. 1996]. Before and during the competition, a hypotonic beverage containing 3 - 6% carbohydrates is recommended. It serves for quick fluid replenishment and has a low electrolyte content [Stefanovsky *et al.* 2012]. The importance of ensuring euhydration before performance, and the potential benefits of temporary hyper-hydration with sodium salts or glycerol solutions, are also important issues.

The insufficient hydration status by the young athletes in the present study may have been caused by poor previous education regarding the importance of fluid intake during the training process and recovery periods. Education is obviously low, therefore we need to not only educate our athletes, but also their parents, and collect feedback from them. The program with feedback is namely far more efficient than that of only providing information [Tate *et al.* 2001].

Limitations of the study

Because the athletes were not from the same place where the competition was held, we did not monitor U_{SG} values during the last week of preparation. We also did not monitor U_{SG} values after waking up on the morning of the competition day. Rehydration is one of the crucial components of an athlete´s optimal regeneration, so in the next research, it would be appropriate to monitor U_{SG} values the following day after the competition.

Conclusions

Young karate athletes competing in weight categories are hypo-hydrated close to the commencement of the fight. Many young athletes, despite health risks, undergo hypo-hydration, the same as adult athletes. Therefore, it is necessary to raise the education of athletes and their parents and to ensure control and feedback. We recommend that karate athletes drink enough liquids before the competition and avoid lowering the body weight by reducing fluid intake. This will prevent inauspicious events that may negatively affect their performance and prolong the regeneration process. The athletes should be educated about the importance of proper hydration to be able to protect their long-term health. For its simple and practical use, USG is a suitable and fast method of determining the degree of hydration not only of karate athletes, but also of other field athletes, not only in the competition but also in the training process.

Conflicts of Interest

The authors declare no conflict of interest.

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