RELATION BETWEEN HYPOHYDRATION AND REDUCTION RATE OF BODY MASS AMONG ELITE YOUTH AMATEUR BOXERS

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Abstract
In this study, we have investigated the relation between hydration status and reduction rate of body mass (ROR). A sample consisted of 24 elite boxers (all males; 16.83 ± 1.01 years of age) from three European countries competing at an official tournament. The variables were collected by urine specific gravity (USG) assessment and an anamnestic questionnaire asking subjects on sports factors. ROR was calculated by dividing body mass by body mass reduced prior to competition. Our study show significant relation between USG and ROR (Rs = 0.65, p < 0.01). Notably, 60% of the participants exceeded USG cut-off assumption (> 1.020 g/ml) for athletes, while the most abundant pattern of body mass reduction was 2 – 5% of ROR reported by 50% of boxers. Boxing authorities could reconsider the official rules and advocate for the integration of an official hydration assessment program aiming to discourage athletes from engaging in harmful weight loss procedures.

Key words: dehydration, weight cycling, combat sports

Introduction
Combat sports athletes are historically associated with competing in weight class categories (WCC). Amateur boxing was the first combat sport to have introduced WCC in 1867 (Smith, 2006). Since then, voluntary body mass (BM) loss in order to accomplish lower WCC has become a habitual practice among boxers. According to recent findings, BM reduction within a few days before competition is achieved exclusively by voluntary dehydration (Reljic et al., 2013). Extreme restrictions in the consumption of food and beverages, training in rubber suits, improper use of a sauna, as well as the use of banned pharmacological agents are frequently reported BM reduction methods adopted by amateur boxers (Reljic et al., 2013; Smith, 2006). Detrimental negative health consequences, including death, have been documented as a result of weight cutting, but this practice is still common in the majority of weight class combat sports (Franchini et al., 2012).

Excessive weight cycling practices during adolescence may affect body development through changes in endocrine mechanisms, such as testosterone release and growth factor linked to insulin-1 (Roemmich & Sinning, 1997). Furthermore, an eating disorder linked to weight making in junior boxers in an attempt to suppress body weight and continue to box domestically has been reported (Lovett, 1990). A higher prevalence of overweight and obesity in former combat athletes exposed to body mass manipulation in comparison with former athletes who were not weight cyclers during their competitive career has also been reported (Saarni et al., 2006).

Two terms related to hydration status are often mistakenly interchanged – dehydration and hypohydration. 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 (Sawka et al., 2007). Vice versa, hypohydration refers to a state or level of hydration after a loss of a certain amount of body water (Cheung, 2010). The consequential dehydration is assumed to be a major adverse effect associated with rapid loss of body mass among amateur boxers (Reljic et al., 2013). Likewise, the resultant hypohydration could adversely affect health and performance outcomes (Fernandez-Elias et al., 2014; Maughan, 2003).

To the best of our knowledge, only two papers were published addressing hydration status of amateur boxers in real-life settings (Pettersson & Berg, 2014; Zubac et al., 2015). Moreover, we weren’t able to find any studies reporting the relation between consequential body mass reduction and hydration status in youth boxers prior to an official competition. Therefore, the first objective of this study was to examine the
relation between hypohydration and reduction rate of body mass (ROR). Furthermore, we have also examined the prevalence of hypohydration and ROR among elite youth boxers.

Methods & Methods

In accordance with the Helsinki Convention, the authors’ Institutional Research Ethics Board approved this study.

Participants

Our study was carried out as a part of preparation bouts between national teams prior to the official World Youth Championship held in April 2014 in Sofia, Bulgaria. The participants included in our study were elite youth boxers, national team members of Croatia, Hungary and Germany (N = 24; 16.83 ± 1.01 years of age, 176.58 ± 8.67 cm, 70.41 ± 16.01 kg, 10.49 ± 2.51% of body mass expressed as fat, 5.83 ± 1.58 boxing experience, 2.46 ± 2.14 ROR). Their participation was voluntary, with written consent from national team managers. The participation criteria were established as follows, a current national champion with international boxing experience (> 25 fights).

Protocol

In agreement with the American College of Sports Medicine (ACSM), hydration testing guidelines, (Sawka et al., 2007) every participant was instructed to provide a small urine sample collected mid flow from the first void in the morning of the competition day. The urine specific gravity (USG) is reflecting on the pre-competition hydration status. The cut-off was based on this organization’s guidelines regarding hydration status: USG < 1.010 indicates a well-hydrated state, USG = 1.010 – 1.020 indicates minimal hypohydration, USG > 1.021 indicates significant hypohydration, and USG > 1.030 indicates serious hypohydration. The limit for minimal hypohydration might be too strict for initial morning void measurements due to the insensible water losses, an absence of fluid intake, and decreased glomerular filtration during sleep. Therefore, a first-morning USG > 1.020 was suggested to point towards a state of hypohydration (Sawka et al., 2007). Moreover, USG had even been suggested as a superior index to detect hypohydration following overnight sleep without fluid intake (Hamutı et al., 2013).

The assessment was performed prior to Croatia – Germany and Croatia – Hungary fights within a seven-day period. The athletes hadn’t trained 24 hours before sampling and were asked not to consume any medications or dietary supplements. The temperature and relative humidity in the testing facility ranged 16 – 19 °C and 50 – 55%, respectively, for all trials. Due to the exceptional competitiveness within the Croatian team (i.e. during 2013 – 2014 the youth team won a total of eight medals in four different WCC competing at major AIBA tournaments), their team manager decided to try out a combined lineup in bout against Hungary and introduced new participants who were not eligible for our survey due to strict inclusion criteria.

The official weigh-in was scheduled for 9 AM. The participants handed out their urine specimens before weigh-in, and after that, they approached the anthropometric measurement. The sample of variables in this study also consisted of anthropometric variables and the data collected in an extensive questionnaire (QWC). The QWC was a combination of previously used questionnaires in which athletes from different combat sports were tested on similar issues (Artioli et al., 2010; Brito et al., 2012; R. Kordi et al., 2011). The instrument had undergone content validity verifications by three researchers before preparing the final draft. Throughout the questionnaire, the participants were asked about anamnestic data on sport factors: competitive experience, current weight class category, and body mass reduced prior to this particular competition (in kg).

Additionally, we calculated the ROR for every single competitor. More precisely, the self-reported average value of body mass for each WCC was divided by self-reported body mass reduced prior to competition, as suggested previously (Casa et al., 2000). The USG was analyzed by an AtagoPal-10s refractometer (Tokyo, Japan) providing accurate readings to 0.001 units. The refractometer was calibrated with distilled water before usage. A glass pipette was used to apply the urine sample to the instrument and the value was digitally read. The RF determined the USG in a range from 1.000 to 1.040; the deflection in the scale was 0.001. The percentage of body mass expressed as fat was calculated according to the protocol previously used in research applied to youth boxers (Reljic et al., 2013). Body mass was measured by official Tanita BC 520 scale (correctness of results 0.1 kg), and body height was measured by a Martin’s anthropometer (correctness of results 0.1 cm).
Statistics

We analyzed data using descriptive statistics of the distribution of variables (mean and standard deviation). The normality of the distribution was tested using Shapiro-Wilk test. Spearman’s range of correlation was used to determine the relation between USG and ROR, because the reduction rate of body mass violated the normality assumption. USG and ROR frequencies were also calculated. The data were analyzed by using Statistica v.12.0 (StatSoft, SAD) package and MS Office 2013. Statistical significance was set at p < 0.05.

Results

Reliability analyses showed appropriate reliability of the testing. Spearman’s R was 0.99 (ROR), while percentage of equally responded queries ranged from 0.90% (competitive experience) – 100.0% (current WCC).

Figure 1

Prevalence of hypohydration and rate of body mass reduction

Note: USG (g/ml^-1) – Urine specific gravity; ROR (%) – rate of body mass reduction

* the data are presented as mean ± standard deviation

Figure 2

The relation between USG values and ROR expressed in percentage

(R_s = 0.65, p < 0.01; CI: 0.28 – 0.81, N = 24).
Discussion

To the best of our knowledge, this was the first study that has examined the relation between hypohydration (USG assessment) and ROR in elite youth boxers (Rs = 0.65, p < 0.01; N = 24). Moreover, we have detected a high prevalence of hypohydration. Almost 60% of participants exceed USG cut-off point > 1.020 g/ml, while the most abundant pattern of weight reduction was 2–5% of body mass reduced, reported by nearly 50% of youth boxers. The most important findings will be discussed in the following text.

Notably, weight cutting practice has been studied among different combat sports (Brito et al., 2012; Kordi et al., 2011), the relation between consequential BM loss and hypohydration on competition day is rarely reported. Spearman’s range of correlation was used to demonstrate relation between hypohydration index (USG) and ROR. According to the presented results (Figure 3.), USG was associated with subsequent body mass reduction (Rs = 0.65, p < 0.01). We found that the self-reported change in body mass explained very little of the variance in hydration status, only $r^2 = 42\%$. Such findings were unexpected and inconsistent with suggestions of (Casa et al., 2000). One possible mechanism accountable could be that, even if USG is broadly advocated as a superior method in the field of assessment of hydration status (Pettersson & Berg, 2014), in order to obtain a far more precise information on pre-competition hydration status of athletes, urine concentration and water balance should be addressed simultaneously, due to close loop system of regulatory neuroendocrine mechanisms, as advocated by (Armstrong, 2007).

We found that only 20% of participating youth amateur boxers had an upon-waking USG $\leq 1.020$ g/ml, a cut-off value suggested as euhydrated state by (Casa et al., 2000). Nearly 60% of our participants were reported significantly hypohydrated, exceeding ACMS cut-off point $> 1.020$ g/ml. Our data are similar to previous findings of Swedish authors who reported prevalence of serious hypohydration prior to competition, in 89% of elite senior boxers and judokas (Pettersson & Berg, 2014). Likewise, nearly half of the athletes in the current study were seriously hypohydrated (USG $> 1.030$ g/ml). Common wisdom suggests that such finding should be corresponding to a $> 5\%$ body mass loss in the morning of competition day as an indicator of hydration status according to (Casa et al., 2000). Vice versa, our findings of serious hypohydration did not correspond to self-reported values of $> 5\%$ body mass loss (see the Results). However, currently suggested cut-off point for USG should not be generalized. Buford (Buford et al., 2006) suggested that wrestlers seem to have higher USG values even when they are euhydrated. Moreover, to support this theory, Reljic et al., (Reljic et al., 2015) have recently demonstrated that regardless of decreased volume of body water and plasma, USG still tended to increase slightly in a control group of elite German combat sports athletes. Therefore, physiological mechanisms underlying this phenomenon in combat athletes are unclear and require further investigation.

The most abundant pattern of ROR reported was 2–5% of BM reduced during final preparation for this competition, while nearly 50% of participants were observed. Smith (Smith, 2006) suggested that English youth boxers experience large fluctuations in BM during a period of growth and maturation. Our findings are in line with such report. Furthermore, in our study, official weigh-in on competition day did not prevent hypohydration. Therefore, our data are also supportive to recent report of Swedish authors (Pettersson and Berg, 2014). Thus, Olympic combat sports athletes with serious hypohydration in the morning are at risk of commencing a fight in a hypohydrated state under the current structure and rules in use at competitions. Boxing governing authorities should seriously consider integration of an official hydration assessment program aiming to discourage athletes from engaging in the harmful weight loss practice. Impaired physiological processes and health risks associated with harmful weight cutting protocols justify the need for screening and detecting consequential dehydration.

We could be criticized for not accounting for laboratory analysis of pathological changes of the urine sample. Furthermore, this investigation is partially based on self-reported data and the subjects might not have told the truth, especially if they felt uncomfortable. However, we believe that the testing design (see Methods, i.e. experience gained from previous studies) decreased this possibility.

Conclusion

The primary objective of this study was to examine the relation between dehydration assessment index (USG) and ROR. Secondly, we also investigated the prevalence of hypohydration and reduction rate of body mass (ROR) amongst elite youth boxers. A significant relation between USG and ROR was observed, however, only 42% of the common variance between USG and ROR was shown. Notably, the official weight in did not prevent the prevalence of hypohydration. Therefore, an introduction of systematic
monitoring of hydration status may be a promising tool that could lead to improvement in athletic performance, but also to significant reduction of health risk in amateur boxing. Novel investigations should address the relation between dehydration asessment markers and ROR in a more comprehensive manner in order to establish facts and reach new conclusions.

References


*This paper was presented in 5th International Scientific Conference „Contemporary Kinesiology“, Faculty of Kinesiology, University of Split, Croatia, August, 28-30, 2015.