

Weigh-in time affects hydration status and acute weight gain in combat sports: A comparison of judo and wrestling

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Abstract

This study aimed to investigate the effect of weigh-in time on hydration status and acute weight gain (AWG). Twenty-seven men judo athletes and 23 men wrestlers voluntarily participated in this study. Body mass and urine specific gravity (USG) of the athletes were measured just before official weigh-in and competition. Two-way analysis of variance (split-plot ANOVA) with repeated measurements (time x sport) were used to determine differences in AWG and USG between groups and measurement times. In case of significant difference between sports, t-tests were applied. There was a significant main effect of time ($p < 0.01$, $ES = 0.25$) on USG. A significant difference was found in USG between official weigh-in and start of the competition in wrestlers ($p < 0.01$) but not in judo athletes. There was significant difference in AWG and AWG% between sports ($p < 0.01$). Moreover, most of the athletes presented high level of dehydration before both official weigh-in and competition. In conclusion, judo athletes could not rehydrate as much as wrestlers despite 15h of recovery. It can be suggested that the period between official weigh-in and competition would be shortened to prevent non-optimal hydration status and rapid weight gain, with caution to allow sufficient recovery period.

Keywords: Martial arts; combat sports; judo; wrestling; weight gain; dehydration.

El momento de pesaje afecta el estado de hidratación y el aumento de peso agudo en deportes de combate: una comparación entre judo y lucha libre

Resumen

Este estudio investigó el efecto del momento de pesaje sobre el estado de hidratación y el aumento agudo de peso (AWG). Veintisiete judokas y 23 luchadores de categoría masculina, participaron voluntariamente. Se midió la masa corporal y la gravedad específica de la orina (USG) de los atletas justo antes del pesaje oficial y de la competición. Para determinar las diferencias en AWG y USG entre ambos grupos y tiempos de medición se utilizó un análisis de varianza de dos vías (ANOVA factorial mixto) con medidas repetidas (tiempo x deporte). En caso de existir diferencias significativas entre deportes, se aplicaron pruebas t. Se encontró un efecto principal significativo en el tiempo ($p < 0.01$, $ES = 0.25$) en USG. Se encontraron diferencias significativas en USG entre el pesaje oficial y el inicio de la competición en luchadores ($p < 0.01$) pero no en judokas, y en AWG y %AWG en ambos deportes ($p < 0.01$). Además, la mayoría de los atletas presentó un alto nivel de deshidratación antes del pesaje oficial y de la competición. En conclusión, los judokas no pudieron rehidratarse tanto como los luchadores, a pesar de disponer de 15 horas de recuperación. Puede sugerirse que el período entre el pesaje oficial y la competición podría acortarse para así

O tempo de pesagem afeta o estado de hidratação e o aumento de peso agudo em desportos de combate: uma comparação entre judo e luta livre

Resumo

Este estudo investigou o efeito do momento de pesagem sobre o estado de hidratação e o aumento de peso agudo (GTA). Vinte e sete judocas e 23 lutadores da categoria masculina participaram voluntariamente. A massa corporal e a gravidade específica da urina (USG) dos atletas foram medidas imediatamente antes da pesagem oficial e da competição. Para determinar as diferenças em AWG e USG entre os dois grupos e tempos de medição, foi utilizada uma análise de variância bidirecional (ANOVA fatorial mista) com medidas repetidas (tempo x desporto). Em caso de diferenças significativas entre os desportos, testes *t* foram aplicados. Um efeito principal significativo ao longo do tempo ($p < 0,01$, $ES = 0,25$) foi encontrado na USG. Diferenças significativas foram encontradas na USG entre a pesagem oficial e o início da competição em lutadores ($p < 0,01$), mas não em judocas, e em AWG e % AWG nos dois desportos ($p < 0,01$). A maioria dos atletas apresentou um alto índice de desidratação antes da pesagem oficial e da competição. Concluindo, os judocas não conseguiram se rehidratar tanto quanto os lutadores, apesar de ter tido 15 horas de recuperação. Pode-se sugerir que o período entre a pesagem oficial e a competição poderia ser encurtado, a

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evitar un estado de hidratación no óptimo y el rápido aumento de peso, aunque con precaución para permitir un suficiente tiempo de recuperación.

Palabras clave: Artes marciales; deportes de combate; judo; lucha libre; aumento de peso; deshidratación.

fim de evitar um estado subótimo de hidratação e aumento rápido de peso, embora com cautela para permitir tempo de recuperação suficiente.

Palavras-chave: Artes marciais; desportos de combate; judo; luta livre; aumento de peso; desidratação.

1. Introduction

Judo and wrestling are weight classified Olympic sports. Athletes mostly resort to rapid weight loss in order to compete in a defined weight category and obtain advantage of competing in a lower weight category (Artioli et al., 2010a). Athletes apply harmful methods to lose weight such as training with rubber suits, fasting, diuretics, laxatives and diet pills and sauna to induce dehydration (Artioli et al., 2010a; Brantland-Sanda & Sundgot-Borhen, 2013). Previous studies with judokas and wrestlers have demonstrated high prevalence of rapid weight loss and dehydration among athletes to reach desired weight category (Artioli et al., 2010a; Gürses et al., 2018; Marquart & Sobal, 1994; Oppliger et al., 2003). Above-mentioned strategies are used by the athletes to gain a competitive advantage of strength and power over an opponent who does not need to resort to weight loss (Jetton et al., 2013).

Rapid weight loss may result in extreme dehydration. Dehydration has negative consequences on athlete's health and athletic performance. Dehydration is generally related to decreased plasma volume with adverse effects on cardiovascular functioning (Jose et al., 1997). Moreover, Chevront and Kennefick (2014) highlighted that dehydration more than 2% decreases endurance, strength and power performance. Even mild dehydration (1-2% of body weight) impairs athletic performance (Kavouras, 2002). Furthermore, impaired body water balance can lead to decreased cognitive functioning such as decreased decision-making time (Cian et al., 2001), reduced levels of alertness (Shirreffs et al., 2004) and reduced psychomotor performance (Smith et al., 2012). Given that the percentage of weight loss is about 5-13% in weight-classified athletes (Matthews et al., 2019; Nancuvil-Suazo et al., 2020; Steen & Brownell, 1990), dehydration may negatively influence performance following dehydration-induced rapid weight loss. However, when weight loss is obtained in a longer period, performance is not affected by weight loss (Koral & Dosseville, 2009).

The time limit for recovery changes according to rules of any given sport and sufficient time-limit is not known. During competitive wrestling and judo events, the official weigh-in is held before 2 and 15 hours before competition, respectively. Athletes try to regain body mass and rehydrate during the period between weigh-in and competition. Even though there are studies related to the effect of dehydration on sport performance, data related to effect of weigh-in time on hydration status and acute weight gain (AWG) in athletes who compete according to weight classes are scarce. A few studies investigated AWG and dehydration in judo and wrestling before official competitions. Ceylan et al. (2020) indicated that most of judo athletes started and completed the day of competition in dehydrated state. Another study by Gürses et al. (2018) noted high prevalence of significant to serious dehydration in judo athletes both at official weigh-in and before competition. Güder (2020) investigated body mass and hydration status changes in wrestlers between weigh-in and competition. The author stated athletes were in dehydrated state at the weigh-in and started competition with dehydrated state despite lowering the level of dehydration. However, we have not come across any current studies investigating the effect of weigh-in time on hydration status and AWG in weight classified athletes. Also, the ongoing debate related to reducing recovery time between weigh-in and competition made us to investigate the differences in AWG and hydration status between judo athletes and wrestlers to see the effect of recovery period. Therefore, the aim of this study was to determine and compare AWG and dehydration between judo athletes and wrestlers. We hypothesized that wrestlers would present less AWG and higher level of dehydration compared to judo athletes due to shorter recovery time between weigh-in and competition.

2. Materials and methods

2.1. Study design

Weigh-in time may have a potential effect on hydration status and AWG of athletes. As weigh-in times are different in judo and wrestling (judo: almost 15h before official start of competition and



wrestling: 2h before official start of competition) (International Judo Federation, 2021; United World Wrestling, 2021) we wanted to determine the differences between athletes from both sports in terms of dehydration and AWG. Therefore, this observational, cross sectional study aimed to compare hydration status and AWG of judo athletes and wrestler before an official tournament. It is important to present the effect of weigh-in time in recovery of the athletes as both judo and wrestling athletes frequently show high level of dehydration before or during competitions.

2.2. Participants

Twenty-seven men judo athletes and 23 men wrestlers voluntarily participated in this study. The criteria to participate included competing at international tournament for the last two years and being weight-cyclers. Athletes' characteristics are displayed in Table 1. There was a significant difference in age, body mass and BFP between judokas and wrestlers. All subjects were informed about the nature of the study and they signed written informed consent form. Ethical approval was obtained from Kastamonu University Clinical Research Ethics Committee.

Table 1. Characteristics of judo athletes and wrestlers.

Variables	All (n=50)	Judo athletes (n=27)	Wrestlers (n=23)
Age (years)	21.2±2.3 (20.6-21.9)	20.4±2.6 (19.3-21.4)	22.2±1.3 (21.6-22.8)*
Body mass (kg)	74.1±13.5 (70.3-77.9)	68.7±7.9 (65.5-66.6)	80.2±15.8 (73.6-86.1)*
Height (cm)	1.74±0.06 (1.72-1.75)	1.72±0.06 (1.70-1.75)	1.75±0.07 (1.72-1.78)
BFP (%)	9.7±4.7 (8.3-11.0)	7.8±2.8 (6.7-8.9)	11.8±5.5 (9.4-14.1)*
Experience (years)	10.9±2.7 (10.2-11.7)	10.7±3.4 (9.3-12.0)	11.2±1.4 (10.6-11.9)

BMI=Body mass index, BFP=Body fat percentage, data are presented as mean and standard deviation with 95% Cis, *p<0.05; significant difference between groups

2.3. Procedures

The official weigh-in was held approximately 15 hours and 2 hours before the competitions for judo and wrestling, respectively. Actual body mass of the athletes was obtained using a calibrated digital scale (Tanita, Japan) at the official weigh-in. Then, athletes were weighted just before the start of the competitions. All procedure was done with the same scale. Acute weight gain and weight gain percentage were calculated as follows (Scott et al., 1994):

$$\text{AWG} = \text{Before competition weight} - \text{Official weight}$$

$$\text{Weight gain\%} = \left(\frac{\text{Acute weight gain}}{\text{Official weight}} \right) \times 100$$

Body composition was assessed with bioelectrical impedance device (Tanita MC-980) only for descriptive purpose. Body fat percentage (BFP) was recorded for each athlete and the height of the athletes was measured with stadiometer to the nearest 1 cm. A urine sample was taken from each athlete immediately before each body mass measurement. The samples were placed in plastic cups and urine specific gravity (USG) was determined with a digital refractometer (ATAGO PAL-10S, Japan). As soon as the urine samples were analysed for USG, they were immediately disposed. USG was classified as well hydrated (<1.010 g.ml⁻¹), minimal dehydration (1.010-1.020 g.ml⁻¹), significant dehydration (1.021-1.030 g.ml⁻¹) and serious dehydration (>1.030 g.ml⁻¹) according to suggestion by National Athletic Trainers' Association (Casa et al., 2000).

2.4. Statistical analysis

Statistical analysis was carried out using SPSS v.23 software. The normality of the data was checked with Shapiro-Wilk test and descriptive methods using skewness and kurtosis coefficients. Descriptive statistics were used to present participants' characteristics. 95% confidence interval for each variable were also given. Two-way analysis of variance (split-plot ANOVA) with repeated measurements (time x sport) were used to determine differences in AWG and USG between groups and measurement times. The sphericity of the data was checked via Mauchley's test and Greenhouse-Geisser correction was used. Partial eta squared (η^2_p) was calculated for independent sample t-test to determine the effect size, using the 0.0099, 0.0588, and 0.1379 considered as small, medium, and large effect sizes (Cohen, 1988). Athletes' characteristics, AWG and AWG% were compared with

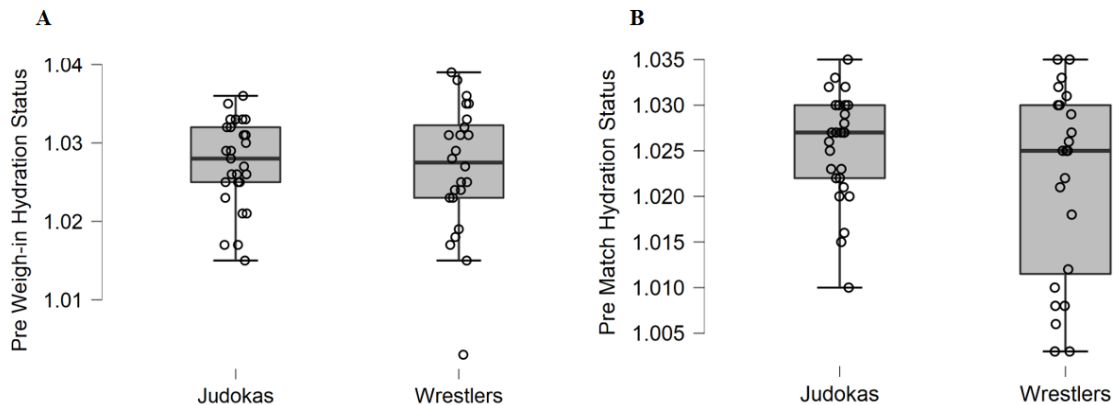


independent sample t-test. Effect sizes were calculated following the recommendations by Rhea (2004). Thresholds values to effect size were <0.25 (trivial), 0.25 to 0.50 (small), 0.50 to 1.0 (moderate) and >1.0 (large). Statistical significance was set at $p < 0.05$.

3. Results

According to two-way ANOVA results, there was no significant interaction of time and sport on USG values of the athletes ($F_{1,49}=3.27$; $p=0.08$; $ES=0.06$) and there was also no significant main effect of sport ($F_{1,49}=1.27$; $p=0.27$; $ES=0.03$) while there was a significant main effect of time ($F_{1,49}=16.13$; $p < 0.001$; $ES=0.25$). USG values of the athletes can be found in Figure 1.

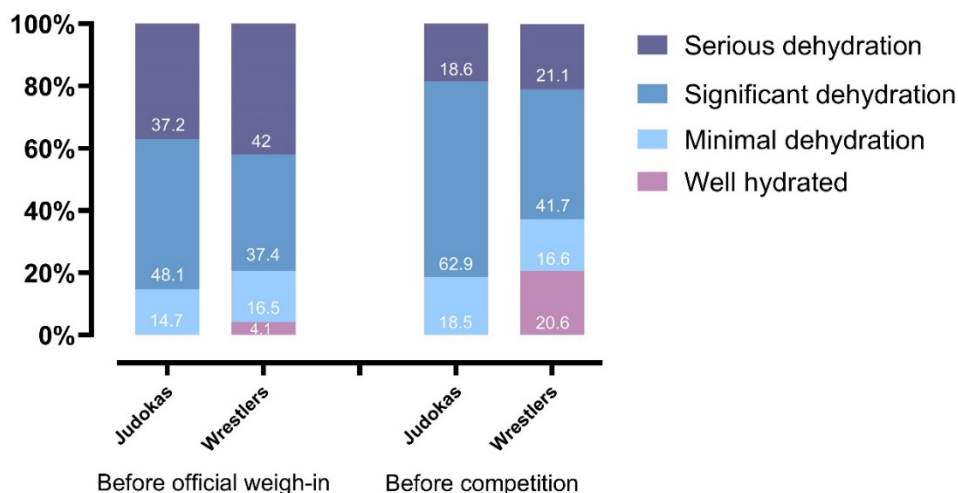
Figure 1. Hydration status of judo athletes and wrestlers before weigh-in and competition



There was a significant interaction of time and sport on body mass ($F_{1,49}=31.45$; $p < 0.001$; $ES=0.39$). Also, there was a significant main effect of time ($F_{1,49}=88.60$; $p < 0.001$; $ES=0.64$) and sport ($F_{1,49}=9.72$; $p=0.003$; $ES=0.17$). There were significant differences for both official weigh-in body mass ($p < 0.001$) and body mass measured just before the competition ($p=0.006$) between judo athletes and wrestlers. Judo athletes weighed 68.6 ± 7.9 kg at the official weigh-in while wrestlers were 80.2 ± 15.8 kg. Just before the start of the competition judo athletes weighed 70.9 ± 8.1 kg and wrestlers weighed 80.8 ± 15.7 kg. There was also significant difference in AWG between sports (judo= 2.3 ± 1.3 kg vs wrestling= 0.5 ± 0.7 kg, $t=5.80$, $df=48$, $p < 0.001$, $d=1.64$ [large]). Correspondingly, judo athletes' AWG percentage was also higher than wrestlers ($3.3 \pm 2.1\%$ vs $0.7 \pm 0.8\%$, $t=5.63$, $df=48$, $p < 0.001$, $d=1.59$ [large]).

Figure 2 present percentages of the athletes according to hydration status classifications. The majority of both judo athletes and wrestlers presented significant to serious dehydration before the official weigh-in. Moreover, most of judo athletes and wrestlers presented significant to serious dehydration before the competition.

Figure 2. Hydration status classifications of the judokas and wrestlers immediately before official weigh-in and competitions as determined by USG.



4. Discussion

This study aimed to investigate the effect of weigh-in time on hydration status and AWG. The most interesting finding of the study was that athletes from both sports showed high level of dehydration before competitions even though judo athletes had more time for recovery. Moreover, judo athletes showed higher AWG and thus AWG% than wrestlers after recovery period.

In the present study, hydration status of the athletes was measured by means of USG. The mean USG values of judo athletes were 1.027 g.ml^{-1} while it was 1.026 g.ml^{-1} for wrestlers at the official weigh-in (Figure 1). In contrast to our findings, in a study by Pettersson and Berg (2014), morning weigh-in athletes presented higher USG values (1.031 g.ml^{-1}) compared to evening weigh-in athletes (1.027 g.ml^{-1}) in the morning of the competition. Moreover, previous studies reported high prevalence of dehydration in judo athletes and wrestlers (Ceylan et al., 2020; Güder, 2019; Gürses et al., 2018; Zambarski et al., 1976). As for judo athletes, they presented high level of dehydration on a competition day with mean USG value of $1.021 \pm 0.007 \text{ g.ml}^{-1}$ (Ceylan et al., 2020), at the official weigh-in and before the competitions with mean USG values of $1.027 \pm 0.006 \text{ g.ml}^{-1}$ to $1.025 \pm 0.006 \text{ g.ml}^{-1}$, respectively (Gürses et al., 2018). Wrestlers were also reported to show high level of dehydration on a competition day with mean USG value of $1.026 \pm 0.007 \text{ g.ml}^{-1}$ (Güder, 2020) and at the official weigh-in and before competition with mean USG values of $1.028 \pm 0.007 \text{ g.ml}^{-1}$, $1.026 \pm 0.005 \text{ g.ml}^{-1}$, respectively. (Zambraski et al., 1976). Our findings were in accordance with abovementioned studies where athletes showed significant to serious dehydration. As a result of findings of the current study, it can be concluded that weigh-in time does not affect the prevalence of dehydration as presence of dehydration is common in judo athletes and wrestlers.

As the prevalence of rapid weight-loss is high across combat sports (Barley et al., 2019), it is not surprising that athletes regain weight following official weigh-in. In the current study, the magnitude of AWG in judo athletes $2.3 \pm 1.3 \text{ kg}$ ($3.3 \pm 2.1\%$) with 15 hours of recovery while it was $0.5 \pm 0.7 \text{ kg}$ ($0.7 \pm 0.8\%$) in wrestlers with 2 hours of recovery. In a study by Alderman et al. (2004), where weigh-in was held the day before competition, wrestlers gained an average of 3.4 kg or 4.81% of body weight between official weigh-in and competition. This AWG is seven times higher than that in the current study. Gürses et al. (2018) stated AWG of $1.3 \pm 1.0 \text{ kg}$ in judo athletes. Artioli et al. (2010b) and Berkovich et al. (2016) reported almost the same magnitude of AWG in judo athletes ($1.6 \pm 1.4 \text{ kg}$, $1.4 \pm 1.0 \text{ kg}$, respectively). Nancuvil-Suazo et al. (2020) investigated wrestlers' AWG during Pan American Championships and presenting the same findings, stating that athletes did not have enough time to increase their body mass in to a significant amount between official weigh-in and their first match. Also, the authors concluded that the change of time in official weigh-in from the day before the matches to the same day is a useful precaution that can prevent athletes from severe weight loss and weight gain. In mixed martial arts (MMA) athletes, AWG was much higher compared to judo and wrestling ($7.4 \pm 2.8 \text{ kg}$, $\sim 11.7\%$) (Matthews & Nicholas, 2017) which has been clearly supported by previous studies with evidence that MMA athletes resort to extreme rapid weight loss and gain before competition (Hillier et al., 2019; Jetton et al., 2013; Matthews & Nicholas, 2017). In line with our findings, Pettersson and Berg (2014) also stated higher magnitude of AWG in evening weigh-in group compared to morning weigh-in group. These differences among combat sport athletes can result from regulations related to weigh-in time. In MMA, official weigh-in is held almost 24 hours before competition while it is held 15 hours and 2 hours before competition in judo and wrestling, respectively. Therefore, we can suggest that recovery time between weigh-in and competition can affect AWG of combat sport athletes.

Combat sport athletes' resort to rapid weight loss due to the perceived competitive advantage. Actually, AWG following rapid weight loss has been associated with improved performance in judo, MMA and wrestling (Coswig et al., 2019; Reale et al., 2016; Wroble & Moxley, 1998). However, there are studies stating no positive effect of AWG on competitive performance (Horswill et al., 1994; Kirk et al., 2020; Reale et al., 2017; Zubac et al., 2018a). Besides, Brenchney et al. (2019) suggests that extreme weight loss may lead to negative competition outcome. Also, Mendes et al. (2013) stated that even weight cyclers cannot refrain from negative consequences of rapid weight loss. Furthermore, Lakicevic et al. (2020) highlighted that rapid weight loss could affect athletes' health, safety and well-being both acutely and chronically. Thus, it is important to minimise this practice among combat sport athletes given that the ambiguous benefits of weight loss and gain



on performance and the potential risks against athletes' health. Moreover, some precautions including weigh-in less than 1 hour before matches, hydration checks before weigh-in and only one opportunity to weigh in for each athlete (Franchini et al., 2012) should be taken for athletes' health and well-being.

This study had some limitations; measuring hydration status via USG has been stated to be a matter of debate (Barley et al., 2020; Zubac et al., 2018b) but it is also suggested to be a reliable tool especially in the field (Cheuvront & Kenefick, 2014) as in the current study. Limited number of combat sport athletes were included in the study; larger samples from different combat sports can be included in the future studies. Although morning USG measurement is stated to provide more appropriate results related to hydration status (McDermott et al., 2017), we carried out some measurements in the evening due to weigh-in time.

6. Conclusion

In the current study, most of the athletes from both sports presented significant to serious dehydration. Thus, it can be concluded that more recovery did not result in better hydration status in judo athletes. Also, they gained much higher body mass following official weigh-in, which may be acceptable as wrestlers had very limited time of recovery following official weigh-in. Thus, further studies are warranted to investigate underlying mechanisms that affect rehydration process following rapid weight loss. Moreover, athletes and especially coaches should be included in educational programs related to adverse effects rapid weight loss and dehydration in combat sports.

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