Associations Among Dehydration, Testosterone and Stress Hormones in Terms of Body Weight Loss Before Competition

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Abstract: *Background:* In weight class sports, such as judo, taekwondo and wrestling, reducing body weight before competitions is common. However, it is recommended that weight loss per week should not exceed 1.5% of total body weight otherwise, athletes' metabolism and endocrine parameters are negatively affected, which will deteriorate their physiology and psychology and thus decrease their performance. The aim of this study was to determine weight loss and hydration levels after weight loss before competitions among the elite wrestlers and to explore the association between hydration levels, and stress and testosterone. *Methods:* This was an observational study. The study was undertaken with 56 voluntary athletes who participated in wrestling championship. With blood samples taken from the wrestlers, glucose, blood urea nitrogen, sodium (Na), cortisol, prolactin and testosterone hormone analyses were evaluated by a specialist at a biochemical laboratory. *Results:* It was found out that according to plasma osmolarity levels, there were significant differences between those dehydrated and those who maintained euhydration in terms of cortisol and total testosterone levels ($P < 0.001$). It was detected that an association was present between plasma osmolarity, and cortisol ($r = 0.667$) and total testosterone levels ($r = -0.627$) among the elite wrestlers. *Conclusions:* It was discovered that elite wrestlers were subjected to quick and high level of weight losses before competitions in a very short time (1–5 days). It was seen that their hydration levels differed due to the weight loss, which was explored to be causing acute dehydration among the wrestlers.

Key Indexing Terms: Body Weight Loss; Stress; Cortisol; Total Testosterone; Dehydration. **[Am J Med Sci 2015;350(2):103–108.]**

In combat sports, athletes are classified according to their body weights and grouped into competition weights. Weight classes in wrestling, which is one of those combat sports, are 55, 60, 66, 74, 84, 96 and 120 kg. It is obligatory that wrestlers should have a body weight appropriate for the weight classes in which they are going to compete when they are weighed in on the day (between 18.00 and 18.30) before the competition. However, many athletes want to compete in lower weight classes by reducing body mass index due to the idea of competing against opponents who are less strong than them, which is, they think, advantageous. Therefore, reducing body weight before competitions is a commonly used method in weight class sports, such as judo, taekwondo, karate and wrestling. Athletes lose body weight using such inappropriate methods as intense exercises, sauna, nutrition and fluid restriction in a very short time (1–7 days) before the competitions.[1–4] In NCAA (Wrestling Weight Certification) it is reported that weight loss per week should not exceed 1.5% of total body weight.[3] Otherwise, a short term high level of weight loss will lead to dehydration, which will result in deteriorations in the athletes' physiology and psychology by causing negative effects on their metabolisms and endocrine parameters and thus their performance will decrease.[1–4]

Dehydration causes a decrease in plasma volume of the organism, acute cardiovascular disorders (arrhythmia, hypotension, tachycardia), breakdown of thermoregulation, decreased activity of immune system, insufficient distribution of nutrition/energy resources and slowdown of metabolic wastes in athletes and, as a result, adversely affects their health and performance.[2,5–7] Because weight losses generally occur in a shorter time, thanks to some methods in combination with nutrition and fluid restrictions; these losses also have detrimental effect on the constituents of body. Furthermore, dehydration causes negative mood state and hormonal changes by increasing the production of stress hormones (cortisol, prolactin) and sex hormones (testosterone).[6,8–12]

The term "stress" stands for any event that increases cortisol secretion.[13] Cortisol is a catabolic hormone secreted from adrenal cortex and has effect on organic metabolism, that is, mobilizing nutrients. It preserves glucose resources by reducing glucose consumption and increasing cortisol hormones. Protein and fat metabolisms are also affected by cortisol levels. While increasing protein catabolism, cortisol decreases protein synthesis. Lipolysis is increased due to energy resources shifted to lipids. Cortisol secretion velocity changes due to stress, for example, prolactin increases, whereas sex steroids decrease.[13–15] Having increased with glucocorticoid due to stress, prolactin insures functioning and survival of T lymphocytes. Prolactin inhibits glucocorticoids associated with stress response and may extend the endurance of immunity against stress.[16] Decreased testosterone, unlike prolactin, is affected by cortisol secretion. Testosterone is the most important sex hormone among the male sex hormones, androgens. Along with the many physiologic functions in human body, testosterone is a crucial anabolic hormone. It stimulates functional sperm production, gland growth of the reproductive system, development of male secondary sex character and growth. Testosterone also stimulates protein synthesis and muscle growth.[13–15] In relation with exercise, testosterone plays an important role in repairing bone, red blood cells, skeleton and muscle. During a certain amount of intense exercise, testosterone increases—as in cortisol—in parallel to the exercise when it is at its peak. After exercises, testosterone level decreases, whereas cortisol level increases due to decreased testosterone.[15,17,18]

It is reported that dietary restrictions and weight loss in a short time lead to negative effects on metabolism and endocrine parameters among the athletes, which disturbs the physiology and psychology leading to reduced performances. Meanwhile, these studies, in which changes seen in stress and testosterone hormones due to exercises are also examined, indicate that there is a negative correlation between stress hormones and testosterone hormones.[2,6,18–21] In wrestling—one

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of these sports with weight classes—wrestlers often change their weight classes. These athletes obliged to participate in the competitions undergo fast weight losses in a short time through inappropriate methods. Quick weight losing in a short time results in dehydration among the wrestlers, and dehydration is thought to cause physical, physiological, psychological and hormonal changes. Yet, in the literature, the number of the biochemical studies on stress and testosterone levels of elite wrestlers is very limited. In this regard, the hypothesis is that dehydration may lead to an increase in cortisol and prolactin levels while decreasing testosterone levels among the wrestlers.

The aim of this study was to determine weight loss and hydration levels based on blood osmolality level of the elite wrestlers before the competitions and to identify the correlation between hydration status, and stress (cortisol and prolactin) and testosterone.

MATERIALS AND METHODS

Recruitment of the Subjects

The sample of the study was composed of 68 elite male wrestlers who participated in international wrestling tournaments in the last 5 years and competed in the Turkish interuniversity wrestling championship (a 5-day tournament) in 2014. Of the 68 elite wrestlers, 12 did not want to give blood samples and declined to participate in the study. The study continued with 56 elite wrestlers. The ages of the athletes ranged from 18 to 22 years; the average age was 22.30 ± 2.43 years; average height was 174.50 ± 6.40 cm; average weight was 78.93 ± 14.41 kg.

For the study, medical ethics approval of Clinical Research Ethics Committee of Antalya Training and Research Hospital was obtained with the decision dated and numbered 06.10.2014 and 49/8-2014-213 in accordance with the guidelines of the revised Declaration of Helsinki. The sample was recruited using random sampling method and informed consents of the athletes were gained with voluntary participation. The participant athletes were asked not to use any kinds of medicine and ergogenic aids within 48 hours before competition-weighing to ensure standardization of the participant athletes. Those having used medicine and ergogenic aids were not included in the study. All participants were healthy, and no diseases that affected the blood values were seen during the study period.

Biochemical Measurements and Analysis

At the time of competition-weighing (a day before the competition, between 18.00–18.30), blood samples of 5 mL were taken from forearm veins of the participant athletes into 8.5-mL tubes with pure gel by specialists with closed vacutainer blood collection system and were immediately submitted to the laboratory where further analysis was performed.

Blood samples were obtained from venous blood and then mixed with EDTA. Plasma was prepared by centrifugation at 4,000 rpm (Nuve NF-400, Ankara,Turkey) for 5 minutes at room temperature and then stored at −20°C before analysis. Biochemical analyses were achieved using Beckman Coulter AU2700 Plus biochemical auto-analyzer with Beckman Coulter kits. Hormone analyses were determined by Roche Hitachi Cobas e601 auto-analyzer with Roche kits.

Experiment Protocol

A personal information form was used to know the amount of body weight lost before the competition, how long it took to lose weight and how weight loss was achieved. The elite wrestlers reported to have lost body weights through sauna, intense exercise and food and fluid restrictions 1 to 5 days before the competition. Hydration levels and dehydration levels of the elite wrestlers were determined according to levels of plasma osmolarity in blood. Those with a plasma osmolarity of <290 mOsm/L were considered to have normal daily body water content (euhydration), whereas those with a plasma osmolarity of >290 mOsm/L were considered to be dehydrated.[22,23]

Dehydration was established using the formula below:

$$\text{Pathologic Plasma Osmolarity} = (2 \times \text{NA}) + (\text{BUN}/2.8) + (\text{Glucose}/18).^{24}$$

Statistical Analyses

The data were assessed with the SPSS program. For the assessment of the data, descriptive statistics were mainly used. Independent 2 samples were assessed using independent Samples *t* test, one of the parametric tests. Correlation status among the variables was evaluated with Spearman's correlation coefficients. The accepted level of significance for all analyses was $P < 0.05$ with 95% confidence interval.

RESULTS

It was found that 60.7% of the elite wrestlers underwent a short term high level of weight loss (1–5 days) before the competitions (3.77 ± 1.85 kg). It was noted that athletes having undergone weight losses had a plasma osmolarity level above the reference range (296.63 ± 4.30) and suffered from dehydration (Table 1).

It was seen that there were significant differences between the athletes dehydrated and those nondehydrated in terms of Na^+ values. Wrestlers dehydrated had considerably high level of Na^+ as compared with those nondehydrated and came close to upper limit of the reference range (Table 1).

It was discovered that there was a significant difference between the dehydrated and not dehydrated athletes in terms of cortisol and total testosterone levels ($P < 0.001$). When the differences were analyzed, dehydrated wrestlers had a higher level of cortisol than those who maintained euhydration but their total testosterone levels were lower (Table 1).

It was detected that an association was present between plasma osmolarity (hydration levels), and cortisol ($r = 0.667$) and total testosterone levels ($r = -0.627$) among the elite wrestlers ($P < 0.001$). In other words, it was found that as plasma osmolarity increased so did cortisol, but not total testosterone. However, it was also seen that there was a correlation between cortisol and total testosterone ($r = -0.537$). When the correlation status was studied, it was detected that as cortisol increased, total testosterone decreased (Figures 1–3).

DISCUSSION

Several factors in sports affect performance of individuals. Methods used for athletic talent selection, basic biomotor abilities, technical-tactical-training methods, sportive nutrition and sportive health are just a few of these. No doubt that the most important factor is the sportive health. Frequently changed rules in such combat sports, such as judo, taekwondo, karate and wrestling, and weight classes make adaptation of the athletes problematic and unbearable in some instances. Athletes lose weight in a short time and as quickly as possible before a competition so that they can adapt themselves to frequently changing weight classes and compete against rivals who are less strong than them to gain advantage. Losing weight quickly and