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The effects of dehydration before competition upon body compositions, leptin hormone and ghrelin hormone among elite wrestlers

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Abstract

The aim of the study was to determine the changes in body compositions and hydration levels before a competition among elite wrestlers and to demonstrate the difference among leptin and ghrelin hormone levels due to dehydration. Pre and post-test measurements were performed among the twenty-four voluntary wrestlers in before an international tournament. A personal information form that addressed pre-competition weight loss duration and demographic variables was administered to the participant wrestlers. Additionally, body compositions were analyzed using BIA (Bioelectric Impedance Analyzer), and with the help of specialists, 5 cc of blood was drawn from the forearm veins of the wrestlers. Sodium (Na+), Blood Urea Nitrogen (BUN), glucose, leptin and ghrelin levels were analyzed in the blood samples. The wrestlers' Plasma osmolarity (P_{Osm}) levels were calculated through Na+, BUN and glucose in a mathematical formula. The wrestlers who had P_{Osm}>290 mOsm/L constituted the weight loss group while the wrestlers who had $P_{Osm} \leq 290$ mOsm/L constituted the non-weight loss group. It was identified that all the body composition variables of weight loss group were different both in the pre-test and post-test. Furthermore, BUN, glucose, P_{Osm} and ghrelin hormone levels of the weight loss group were different whereas there were no differences in sodium and leptin levels. As a result, it was found that wrestlers who lost weight before a competition did it quickly; therefore, wrestlers who underwent significant changes in their body compositions demonstrated serious increases in P_{Osm} and ghrelin hormone levels.

Keywords: Hydration status, Plasma osmolarity, Leptin hormone, Ghrelin hormone.

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Introduction

Nearly 25% of the Olympic medals go to combat sports and these sports are watched by millions of spectators. Almost in all combat sports, athletes are classified according to their body mass, so the matches are more equitable in terms of body size and strength. However, many athletes think that competing against a rival who is lighter will gain advantage for them so they perform a rapid weight loss. Although negative effects of rapid weight loss upon human health have been proven well, it is reported that rate of weight loss after losing body weight quickly is higher among such weight sports as judo, karate, taekwondo, boxing and wrestling [1].

The death of six college wrestlers in six weeks in the United States of America drew attention of the world. As a result of the autopsy, it was found that the wrestlers died of weight loss performed in a short time and they performed 15% of dehydration of total body weight [2]. Following these deaths that occurred in 1997, the National Collegiate Athletic Association (NCAA), developed and laid out new measures to ban practices of unsafe weight loss [3,4]. After the studies in relation to this issue, the NCAA decided that competition weighting should be conducted in a nearer time to the tournament and new weight classes should be designed by adding +3 kilos [5]. Additionally, under the Wrestling Weight Certification (WWC), it is recommended that weekly body weight loss should not exceed 1.5% of body weight [6]. Maughan et al. reported that a body mass loss of 2%-7% results in 7%-60% performance decrease. Yet, it was observed that body fluid loss of 1-2% did not have any significant effect upon performance during an endurance exercise lasting <90 minutes whereas performance was negatively affected by body fluid loss of ≥ 2% during an endurance exercise lasting >90 minutes [7].

Athletes who lose weight quickly and in a short time through different methods (sauna, intense and repetitive exercise programs, fluid and food restriction) lose fluid and electrolyte and undergo dehydration. Although there is a simple and easy definition for dehydration, its physiological definition is not so easy and simple [8]. During dehydration, a body experiences both physical (body weight, body mass index, etc.) and physiological (basal metabolic rate, total body fluid volume, fat-free mass and fat mass, etc.) decreases due to fluid and food restriction [9-11]. In addition to these decreases, it is reported that athletes have some hematological changes in hydration markers, too [12-14]. In the last 20 years, many methods have been designed to detect hydration levels in human body. Change in body weight, change in hematological and urine parameters, bioelectric impedance, skinfold thickness, heart rate and changes in blood pressure are some of these markers. However, P_{Osm}, urine osmolality (UOsm) and urine specific gravity (Usg) are the most common and the safest hydration measurement methods [15]. In clinic studies; a reference range recommended for P_{Osm} is between 275 and 295 mOsm/L. There is a pathological cutoff score for euhydation status and P_{Osm} euhydation score is ≤ 290 mOsm/L which means that if P_{Osm} level is >290, then dehydration occurs in individuals [16].

Previous studies reported that in terms of dehydration, changes may be seen in P_{Osm} and Na+, BUN and glucose levels depending on P_{Osm} [17-19]. Depending on these hematological changes, changes in body compositions and even decreasing fat mass, it is expected that changes in concentrations of leptin hormone secreted by adipose tissues and concentrations of ghrelin hormone secreted by stomach fungus will occur because leptin and ghrelin are two hormones that have been proved to have a significant effect on energy balance. Leptin is a mediator of long-term regulation of energy balance because it suppresses food intake and therefore leads to weight loss. On the other hand, ghrelin is a fast-acting hormone and it seems that it plays a role in meal initiation [20]. Many studies on leptin and ghrelin hormone levels have shown different results [21-24]. Therefore, accurate mechanisms that indicate concentrations of leptin hormone secreted by adipose tissues and concentrations of ghrelin hormone secreted by stomach fungus have not been understood exactly. In this sense, it was the hypothesis of the current study that it is expected to see some changes in body composition and leptin and ghrelin hormone concentrations caused by dehydration performed before competitions.

Although the number of the studies that examined the effect of dehydration before competition upon body compositions and hydration markers is high [11,25,26]; we have not seen any studies that examine the effect of pre-competition dehydration upon leptin and ghrelin hormone concentrations. In this context, the current study aimed to determine the effect of pre-competition dehydration upon body compositions, leptin and ghrelin hormone concentrations among elite wrestlers.

Materials and Methods

Subjects

The sample of the study consisted of twenty-four voluntary wrestlers who participated in the camp of the junior male freestyle wrestling national team. In the camp that lasted 25 days before an international tournament, pre-test and post-test measurements were performed among the wrestlers. The voluntary participants were asked not to take any anti-inflammatory and/or ergogenic aids for 72 hours before the measurements in order to achieve study standardization, and those athletes who took these aids were not included in the study. The pre-test measurements of the study were done with 25 athletes but one athlete was dropped out of the study owing to his illness.

Applied measurements

Measurement of height and body weight: Body heights of the wrestlers were measured with bare feet through a Seca brand stadiometer with 0.01 sensitivity.

Measurement of body composition: Body composition variables of the wrestlers [Body Weight (BW), Body mass index (BMI), Basal metabolic rate (BMR), Fat mass (FM), Free-Fat Mass (FFM) and Total Body Water (TBW)] were measured and calculated in wrestling suit with a tare of 250 gr through BIA (TANITA BC 418, USA).

Experimental design

In clinical studies, the recommended reference range of P_{Osm} for euhydation is 275-295 mOsm/L. As in each marker for which recommended reference ranges are given, there is a pathological cutoff score for euhydation status, and a pathological cutoff score for euhydation status is ≤ 290 mOsm/L [16]. In the current study, the wrestlers who had P_{Osm}>290 mOsm/L were classified as the weight loss group while the wrestlers who had P_{Osm} ≤ 290 mOsm/L were classified as the non-weight loss group.

P_{Osm}= (2*NA)+(BUN/2.8)+ (Glucose /18) equation was used [27].

Biochemical analysis

The pre-test measurements were performed at the beginning of the national camp (between 06:00 and 06:30 pm). The post-test measurements, after 20 days of the pre-test, were performed at the competititon weighing time (between 06:00 and 06:30 pm). Blood samples of 5 cc. were taken from forearm veins of the participant athletes into Vacuetta Greiner brand heparin tubes by experts. The blood samples were instantly centrifuged with Nüve NF-400 for 10 minutes at 3000 RPM. Centrifuged blood samples were put into eppendorf tubes and dissolution of the samples was prevented using dry ice during the delivery to the laboratory. Plasma samples were kept at a temperature of -85°C until the day when they would be analyzed, and the serum samples were stored at room temperature for 1 hour and dissolved on the day of the analysis.

Biochemical analyses of hydration markers (Na+, BUN, Glucose) were done using Roche Cobas C501 biochemical auto-analyzer (Roche Diagnostics International Ltd., Rotkreuz, Switzerland) with Roche kits. The results were shown in mg/dl for glucose and BUN while in mEq/L for sodium. As for hormone analyses (Leptin, Ghrelin), Human Elisa kits of SunRed brand were used (Jufengyuan Road, Baoshan District, Shanghai, China). Absorbance reading was carried out through ChemWell 2910 brand elisa reading device (Awareness Technology, Inc. Martin Hwy. Palm City, USA). The results were shown in ng/ml for leptin and in pg/ml for ghrelin.

Statistical analysis

For the analyses of the study, in addition to descriptive statistics, Shapiro-Wilk test was employed for normality test. In inter-group comparisons of the variables that followed a normal distribution, Independent-Samples T test was used whereas Paired-Samples T test was used in intra-group comparisons. Moreover, percentage differences between the pre-test and post-test results were calculated with

$\%\Delta = [(\text{Post-test} - \text{Pre-test})/\text{Pre-test}] \times 100$ for each variable.

Results

Twenty-four voluntary wrestlers who participated in the camp of the junior male freestyle wrestling national team were included in the study (age: 19.33 ± 0.70 years, height: 173.00 ± 8.26 cm, sport age: 7.83 ± 1.79 years). When the participant wrestlers were classified, there were not any statistically significant differences between weight loss group (n=15) and non-weight loss group (n=9) in terms of age, height, and sport age (p>0.05). In the study, it was identified that 62.5% of the participants lost weight whereas 37.5% of them did not lose weight. Among the wrestlers who lost weight, 60% of them performed weight loss practices 1-7 days before competitions whereas 40% of them performed weight loss practices 8-14 days before competitions.

Table 1. *Comparison of measurements of wrestlers' body compositions.*

Variables	N	Groups	Pre-test	Post-test	p	%Δ
BW kg	15	Weight loss	79.91 ± 20.94	75.49 ± 20.66	0.001**	-5.73
	9	Non-weight loss	87.73 ± 18.49	86.86 ± 18.63	0.218	-
		P	0.366	0.182		
BMI kg/m^2	15	Weight loss	27.01 ± 5.14	25.53 ± 5.08	0.001**	-5,56
	9	Non-weight loss	27.86 ± 3.71	27.57 ± 3.84	0.203	-
		P	0.673	0.313		
BMR kcal	15	Weight loss	2071.60 ± 418.04	1964.93 ± 412.16	0.001**	-5.25
	9	Non-weight loss	2311.11 ± 374.52	2271.78 ± 381.97	0.011*	-1.76
		P	0.172	0.084		
FM kg	15	Weight loss	11.09 ± 8.81	9.85 ± 8.62	0.017*	-11.91
	9	Non-weight loss	10.87 ± 8.04	11.09 ± 7.96	0,662	-
		P	0.950	0.730		
FFM kg	15	Weight loss	68.53 ± 12.81	65.66 ± 12.94	0.005**	-4.27
	9	Non-weight loss	77.09 ± 11.37	75.78 ± 11.67	0.007**	-1.77
		P	0,113	0.068		
TBW kg	15	Weight loss	50.67 ± 9.40	48.06 ± 9.47	0.001**	-5.30
	9	Non-weight loss	56.43 ± 8.33	55.48 ± 8.56	0.009**	-1.76
		P	0.144	0.068		

*p<0.05; **p<0.01

When wrestlers were classified according to weight loss; it was identified that there were not any statistically significant differences in the comparison of body composition values between the weight loss group and non-weight loss group in both pre-test and post-test (p>0.05). However, when intra-group comparisons were examined; it was seen that there were statistically significant differences in all body compositions among the weight loss group (p<0.05). Additionally, the weight loss group decreased by -5.73% in body weight, by -5.56% in BMI, by -5.25% in BMR, by -11.91% in FM, by -4.27% in FFM, and by -5.30% in TBW. On the other hand, it was found among non-weight loss group that there were not any statistically significant differences in terms of BMI and FM (p>0.05), while statistically significant differences occurred in terms of BMR, FFM and TBW levels (p<0.05), and this group decreased by -1.76% in BMR, by -1.77% in FFM, and by -1.76% in TBW (Table 1).

When wrestlers were classified according to weight losing, it was identified that there were not any statistically significant differences in the comparison of all biochemical and hormone markers between the weight loss group and non-weight loss group in both the pre-test and post-test ($p>0.05$). When the post-test values were compared, it was seen that statistically significant changes occurred in BUN, Na+ and P_{Osm} levels ($p<0.05$), while glucose, leptin and ghrelin hormone levels did not differ significantly ($p>0.05$). Furthermore when all biochemical and hormone markers of the pre-test and post-test values were compared, it was identified that there were not any statistically significant differences among non-weight loss group ($p>0.05$). As for the weight loss group, there were not any statistically significant differences in Na+ and Leptin hormone levels ($p>0.05$) whereas there were statistically significant differences in BUN, Glucose, P_{Osm} and Ghrelin hormone levels ($p<0.05$). Accordingly, this group decreased by 46.59% in BUN, by 15.40% in glucose, 1.80% in P_{Osm} but their ghrelin levels increased by 3.53% (Table 2).

Table 2. *Comparison of measurements of wrestlers' biochemical and hormone markers.*

Variables	N	Groups	Reference range	Pre-test	Post-test	p	%Δ
BUN mg/dl	15	Weight loss	8-20	11.92 ± 1.49	17.31 ± 3.68	0.001**	46.59
	9	Non-weight loss		13.03 ± 1.04	13.12 ± 3.24	0.933	-
		P		0.063	0.01*		
Glukoz mg/dl	15	Weight loss	74-106	84.21 ± 5.30	96.85 ± 12.96	0.003**	15.40
	9	Non-weight loss		84.47 ± 5.69	101.52 ± 27.32	0.073	-
		P		0.911	0.574		
Na+ mEq/L	15	Weight loss	136-146	140.87 ± 2.17	142.13 ± 1.85	0.089	-
	9	Non-weight loss		139.33 ± 0.87	138.22 ± 3.31	0.357	-
		P		0.06	0.001**		
POsm mOsm/L	15	Weight loss	275-295	290.67 ± 4.61	295.83 ± 3.91	0.005**	1.80
	9	Non-weight loss		288.01 ± 1.85	286.77 ± 4.77	0.507	-
		P		0.115	0.001**		
Leptin ng/ml	15	Weight loss	-	35.41 ± 22.65	35.97 ± 22.41	0.639	-
	9	Non-weight loss		30.76 ± 23.10	33.18 ± 24.37	0.240	-
		P		0.634	0.777		
Ghrelin pg/ml	15	Weight loss	-	5579.53 ± 3208.88	5828.87 ± 3442.48	0.028*	3.53
	9	Non-weight loss		5243.11 ± 3771.38	5385.44 ± 3775.59	0.574	-
		P		0.818	0.771		

*p<0.05; **p<0.01

Discussion

The participant wrestlers were divided into weight loss group and non-weight loss group in terms of P_{Osm} levels. When body compositions of the weight loss group and non-weight loss group in both pre-test and post-test measurements were compared, it was identified that there were not any statistically significant differences ($p<0.05$), which indicated that the groups were homogenous in terms of body compositions in order to make comparisons. In the study, when the pre-test and post-test measurements of the groups were examined, it was seen that the weight loss group reduced BW by -5.73%, BMI by -5.56%, BMR by -5.25%, FM by -11.91%, FFM by -4.27% and TBW by -5.30%. Moreover, 60% of the weight loss group lost body weight 1-7 days before the competitions (in a week) whereas 40% of them lost body weight 8-14 days before the competitions (in two week). As for the non-weight loss group, their BW, BMI and FM values did not change whereas their BMR values reduced by 1.76%, FFM values by 1.77% and TBW values by 1.76% (Table 1). In the literature, it was suggested that weight losing by 2% did not lead to any functional losses [28,29]. We are of the opinion that decreases among non-weight loss group (BMR, FFM and TBW) resulted from the definition done during exercises.

Dehydration is an inevitable result of exercises. It is important to minimize dehydration during the exercises in both physiological and psychological terms in order to get a maximum performance. Particularly, those athletes doing combat sports (wrestling, boxing, judo, karate) generally try to lose weight through excessive sweating (sauna, wearing plastic or rubber sports suits) and restricting fluid and food intake greatly a couple of days before competitions (5-7 days) so that they can compete against rivals who are less strong and weaker than themselves in order to gain advantage [30]. Wrestlers think that time between competition weighing and competition time (≈18 hours) is enough for rehydration after dehydration. However, studies report that this time period of ≈18 hours is not enough to regain the body-weight lost [31] and dehydration decreases athletes' performances, too [32].

Furthermore, it is reported that when athletes perform such activities, they undergo some hematological changes [12-14]. P_{Osm} has been used in many studies in order to determine dehydration hematologically [19,33,34]. P_{Osm} level is found with the help of mathematical formula using Na+, BUN and glucose levels. Depending on changes in P_{Osm} levels, levels of Na+, BUN and glucose change, too [19,27].

In the current study, it was found in the pre-test and post-test measurements that there were not any statistically significant differences in terms of all biochemical values (Na+, BUN, glucose, P_{Osm}) and hormone values (leptin and ghrelin) among non-weight loss group ($p>0.05$). As for the weight loss group, their Na+ and leptin hormone levels did not differ significantly ($p>0.05$) whereas their BUN, glucose, P_{Osm}, and ghrelin hormone levels changed significantly ($p<0.05$). Bergeron et al. argued that Na+ concentration generally remains high due to excessive sweating caused by long physical activities and even suggested that Na+ concentration goes up gradually depending on the duration of the activities [35]. In the current study, both groups were compared in regard to Na+ concentrations in the pre-test and post-test measurements, and it was found that no statistically significant differences occurred. However there was a numerical rise in Na+ level among the weight loss group. Post-test Na+ concentration value of the weight loss group was 142.13 mEq/L. This evident increase made us conclude that athletes may have undergone hypoosmolar pressure. Actually, if Na+ concentration in blood is ≥ 145, it is called as hypernatremia [36]. Hypernatremia is related to Na+ concentration rising above the normal level in plasma, which occurs either when there is fluid loss or when excessive Na+ accumulation occurs [37]. Extracellular osmolarity increasing in hyperosomolar cases causes dehydration and affects brain cells most. In hypernatremia, neuro-psychiatric signs are clinically evident. Clinical signs of hypernatremia are anxiousness, overaction, lethargy, muscle contraction, spasticity, convulsions, coma, and sometimes mortality [38]. In this sense, sodium concentration that goes up with dehydration may cause athletes to demonstrate hypernatremic reactions. BUN scores of the groups that lost weight depending on rising sodium level showed statistically significant differences in the pre-test and post-test measurements ($p<0.05$), and actually BUN values increased by 46.59% (Table 2). This made us conclude that excessive Na+ accumulation in body due to increasing dehydration raised BUN values.

Some studies on dehydration-induced glucose values reported that there were not any statistically significant differences [39,40]. However, the current study indicated that glucose values of the weight loss group increased, which made us argue that adrenalin increasing due to exercises turns glycogen stored in liver into glucose and glucose flows into blood and regulates blood glucose level.

In the current study, it was explored that there were statistically significant differences in ghrelin hormone concentration of the weight loss group in terms of changes in their body compositions and hydration markers ($p<0.05$). Some studies in the literature emphasize that ghrelin concentration is in negative relation with FM and BMI [41,42]. Actually, the current study pointed out that there were decreases in body fat percentage and body mass index of the athletes that lost weight. In this sense, the current this study concurred with other studies in the literature. It is expected that leptin concentration that works in contrast in food intake decreases in response to increasing ghrelin concentration in dehydration. However, in the current study, leptin hormone concentrations did not differ statistically and significantly among the weight loss group ($p>0.05$). For us, the explanation of this finding may be that athletes undergo weight loss for 8-10 times in a year in order to participate national and/or international competitions, and, as a result, they suffer from excessive body weight loss or demonstrate excessive fluctuations in body weight. However, since they are accustomed to these situations, they may be invulnerable to hunger both psychologically and physiologically, which, in turn, may produce no statistically significant differences in leptin hormone concentrations of these athletes.

In summary, it was detected in the study that wrestlers performed rapid weight loss, which in turn indicated that they underwent some changes both in body compositions and hematological parameters. An increase in P_{Osm}, in particular, pointed out that athletes participate in competitions with inconvenient body fluid volumes. This may cause them to give hypernatremic reactions during competitions.

Considering the fact that one wrestler takes at least five consecutive matches in a day in a tournament, it is not logical to lose weight fast before the competitions. However, if it is inevitable to perform weight loss, it is advisable to follow the NCAA regulations and to lose weight over time on a gradual slope. This may help P_{Osm} levels to be kept between the desired reference ranges (275-295 mOsm/L). If P_{Osm} level is kept between the desired references ranges, this will indicate that athletes are not under hyperosmolar pressure. Thus they will participate in competitions with suitable fluid volume and hydration status will not be a hindrance for the competition performance.

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