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ABOUT THIS SPECIAL ISSUE

If we want to know the importance of exercise in human health, we will see that the beneficial effects of exercise in the prevention - treatment and control of many cardiovascular and respiratory disorders show that life is more important today.

It is not bad to mention here the statistics of patients with heart diseases and heart attacks, which kill a large number of people every year, according to the latest research conducted in Turkey, is the highest rate of death from heart disease.

Health and physical ability are divine blessings. Man always wants health and vitality. The happiness of every human being depends on a force of his body and soul.

For this reason, many researchers and university professors study the effects of exercise on human health and every day we see new findings from this research. This collection is a very small part of the researchers' findings that are made available to those interested readers.

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CONTENT (ORIGINAL RESEARCH / REVIEW ARTICLE

SP-29

HOW MUCH FLUID LOSS AND URINE DENSITY CAUSED BY AEROBIC EXERCISE AND SAUNA IN TENNIS PLAYERS? A DESCRIPTIVE STUDY?

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ABSTRACT

The study aimed to determine the amount of fluid loss with aerobic exercise and sauna protocols, and to compare the change in urine density in the same amount of fluid lost with aerobic exercise and sauna. Thirty-five tennis players (mean age: 24.36 ± 4.03 years R=18-32) training 3 hours/day, 2 times/week (mean training age: 4.07±1.43 years (R=2-6 years) participated voluntarily. Method: Bodyweight by using a scale and height by using a stadiometer were used to measure. Kücükkubas, (2007) and Siri Formula (1956) were used to determine the body density and body fat percentage respectively. Bruce protocol was used to determine Maximal Oxygen Consumption (VO_2max) for calculation of the intensity from VO_2max by using the Karvonen method on the first day with controlled hydration status of the athletes to be hydrated. Firstly, at the predetermined %60 of VO_2max for 6x15 min (8 minutes rest interval) on the treadmill with a total of 90 minutes of running exercise were applied. Secondly, 48 hours later, the amount of fluid and body weight lost during aerobic exercise was also made lost in sauna protocol and urine density was controlled. Thus, urine density corresponding to the same amount of fluid loss lost in aerobic exercise and sauna was compared. **Results:** The values of USG were significantly different pre-exercise (1.016±4.1 g/cm^3) from after exercise (1.024±3.10g/cm^3) ($p < 0.01$); pre-sauna (1.016±4.33) from post-sauna (1.022±3.05) and pre-exercise (1.016±4.1 g/cm^3) and post sauna (1.022±3.05). **Conclusion:** Using hydration status is a good strategy for athletes monitoring body weight before training sessions or competitions to maintain proper hydration. Moreover, questioning the amount of mineral quantity and content loss or with fluid and mineral intake during fluid loss in aerobic exercises and tournament environments will shed light on future studies.

Keywords: Aerobic Exercise, Tennis player, Dehydration, Fluid Loss, urine density, sauna

INTRODUCTION

Tennis matches and training cause athletes to stay on the court for quite a long time (1). Fluid loss due to long-term stay on the court may cause different effects on different age and training level groups who are playing both recreationally and/or as a competitor. [1,2] This may result in heat-related injury or/and decrease peak performance. [3,4] Physiological exertion in a long time duration and thermoregulatory condition may lead to impairments in performance.[5] Moreover, in the case of insufficient hydration, death may occur as a result of impaired cognitive functions, neurological dysfunction and aggravation of dehydration. [6,7] When all these factors are considered, exercise or sauna studies have been focused to determine the effect of dehydration and athletic performance. [8-10] During real matches in tournaments measuring fluid loss, hydration status and core temperature were difficult. [11] In this context, playing tennis in different weather conditions. [3,12] heat stress, court floor [13] and opponent level [14] may change the quantity of fluid loss and performance parameters. [4,14] Due to the fact that playing tennis looks like an aerobic system predominantly, it includes different loads in matches with different energy systems in its content. On average, playing tennis is 60% aerobic loading looking at the total match time. [14; 15] The frequency also changes in professional tennis players who play more than seven matches within two weeks. [4,12] Moreover, the frequency of matches increases as a result of matches postponed in adverse weather conditions. Failure to replace the fluid loss in hot environments can impair performance in athletes, increase in the level of difficulty perceived was reported as well as a decrease in plasma volume. [14,16] In addition to that thirst is not an indicator of body water status. [1,2] Although replacing the loss of fluid amount ensures fluid and electrolyte balance are important in terms of performance. [16-18] replacing fluid does not always mean replacing the electrolyte loss. [2] Furthermore, hyponatremia was observed in athletes due to excessive water consumption, especially in American football and tennis, played in hot and humid weather. [19] Sodium intake has been suggested to prevent hyponatremia as a result of excessive fluid consumption. [2,20,21] Moreover, it has also been reported that athletes experience dehydration despite fluid intake. [16]

Despite the loss of body weight with individual differences, the quantity of the body water loss by bodyweight weighing is a convenient method to determine the amount of fluid loss. Therefore, determining the amount of fluid loss with aerobic exercise and sauna protocols and comparing the change in urine density with the same amount of fluid lost with aerobic exercise and sauna will be beneficial, useful and will shed light on future scientific studies to sport scientists, coaches and athletes. For this reason, the objective of the current study is to determine how much fluid loss is caused by aerobic exercise in tennis players with no fluid intake. In addition to that, the objective of the present study was to compare the change in urine density in the same amount of fluid lost with aerobic exercise and sauna.

MATERIALS AND METHODS

Subjects: Thirty-five tennis players between 18 to 32 (mean age: 24.36 ± 4.03 years) training 3 hours/day, 2 times/week (mean training age: 4.07 ± 1.43 years) between 2-6 years of training ages participated voluntarily in the present study. After the participants were informed about the study, they signed the voluntary consent form. The study was prepared following the World Medical Association Helsinki Declaration rules. The ethics committee approval was obtained (dated 08.11.2018, protocol number 2018/168, decision no: 11).

Anthropometric Measurements

Bodyweight (BW) was measured by using a scale (Tanita TBF-418 Body Fat Analyzer, Tanita Corp., Tokyo, Japan). The Height (H) of the subjects were measured barefoot to the nearest ± 0.1 cm with reference to the Frankfort plane horizontal by using a stadiometer (SECA, France). Body mass index (BMI) was calculated by the formula: body weight (kg) divided by squared height (m^2). To calculate the body fat percentage of the athletes, subscapular, abdomen and thigh skinfold measurements were completed as described in Eston and Reilly, [21] Kücükkubas, [22] formula and Siri Formula [23] were used to determine body density and body fat percentage respectively.

Maximal Oxygen Consumption (VO_2max): Bruce protocol was used to determine VO_2max for calculation of the intended intensity from VO_2max by using the Karvonen method [24] on the first day with controlled hydration status of the hydrated athletes.

The *Karvonen method (*24) factors in resting heart rate (HR_{rest}) to calculate target heart rate (THR), using a range of 50–85%:

$THR = ((HR_{max} - HR_{rest}) \times \%Intensity) + HR_{rest}$

Urine Density-Urine Specific Gravity (USG) Measurement: The urine density of the athletes was checked using a refractometer (Soif brand, China) to make sure they were hydrated so that the established exercise and sauna protocol could be applied. Before each measurement, the refractometer was calibrated with distilled water.

Exercise and Sauna Protocol:

Firstly, the subjects were dehydrated at the predetermined 60% of VO_2max for 6x15 min (8 minutes rest interval) on the treadmill with a total of 90 minutes of running exercise protocol. Secondly, 48 hours later, the amount of fluid loss and body weight loss during aerobic exercise was also made lost in the sauna. Urine density corresponding to the same amount of fluid loss lost in aerobic exercise and sauna was measured. Before each USG measurement, the refractometer was calibrated with distilled water.

Research Design

Figure 1. Research Design

VO_2max measurements were completed immediately after anthropometric measurements were made on the first day. Bruce protocol was used to determine VO_2max for calculation of the intended intensity from VO_2max by using the Karvonen method (24) with controlled hydrated status of the athletes. The Third day, urine density was checked for the hydration status of tennis players. If the value was normal limits, they were included in the exercise protocol. Athletes were dehydrated at the predetermined %60 of VO_2max for 6x15 min (8 minutes rest interval) on the treadmill with a total of 90 minutes of running exercise without fluid intake. On the fifth day, dehydration conditions were checked with a refractometer to be sure that tennis players were at normal hydration status. Then, tennis players were asked to stay in the sauna as long as they could in order to ensure that the amount of fluid they lost in the exercise protocol was lost in the sauna. They came out whenever they wanted during their stay. BW was checked at each exit, and the protocol was terminated when they lost the amount of fluid they lost during the exercise. Before and after the sauna protocol, dehydration conditions were recorded with a refractometer (Figure 1).

Statistical Methods

Data were collected, tabulated, then analyzed by using the software SPSS version 24. Normally distributed numerical data were presented as mean ($\bar{x}$) and standard deviation (SD). A two-sided p-value of <0.01 was considered statistically significant. Paired samples T-test was used to compare the difference and was interpreted as follows: p-values <0.01 were considered statistically significant.

Findings

Physical Parameters of the Tennis Players

Table 1 shows the physical parameters of the tennis players. Average values of the participants were: age = 23.34 ± 3.33years; VO_2max = 54.83 ± 7.54 ml/kg/min (R= 38.19 - 69.08), tennis training ages = 3.29 ± 1.43years; BW = 70.88 ± 7.50 kg; calculated BMI was 22.76 ± 2.58, BF% as 8.76 ± 3.06%, height 1.77 ± 0.06 m.
Physical parameters of the athletes were as follows; height=1.75 ± 0.06 m (R=1.70-1.88), BW = 71.00 ± 8.37 kg (R = 57.70 - 87.20).

Table 1. Descriptive Statistics of Physical Parameters of the Tennis Players (n: 35)

	$\bar{x}$-SD	min-max
Age (years)	23.34 ± 3.33	18-32
VO_2max (ml/kg/min)	54.83 ± 7.54	38.19-69.08
Training Age (years)	3.29 ± 1.43	2.00 – 6.00
BW (kg)	70.88 ± 7.50	57.70-87.20
Height (m)	1.77 ± 0.06	1.69 - 1.90
BMI (kg/m^2)	22.76 ± 2.58	18.87-30.53
BF%	8.76 ± 3.06	2.66 - 14.75

The dehydration results of the tennis players (Table 2) demonstrated that pre-exercise USG values were 1.016 ± 4.1 gr/cm^3 were hydrated in the normal ranges. However, after exercise, the mean of urine densities of tennis players was medium dehydrated (1.024 ± 3.10gr/cm^3**)**. After 48 hours the rest period, the amount of fluid loss as well as body weight lost during aerobic exercise was also lost in the sauna and urine density was controlled. Thus, urine density corresponding to the same amount of fluid loss lost in aerobic exercise and sauna was measured and compared. Pre-sauna mean USG values were 1.016 ± 4.33 gr/cm^3 48 hours after exercise protocol, after sauna values of the tennis players were 1.022 ± 3.05 gr/cm^3. By the same schedule the values of BW and %change were also measured pre- and post-exercise and pre- and post-sauna for exercise were 1.73 ± 0.54 kg and 2.45 ± 0.74%; and for sauna were 1.43 ± 0.42 kg and 2.01 ± 0.56% respectively (Table 3).

Table 2. Hydration Status of Tennis Players (n: 35)

	$\bar{x}$-ss	**min-max**
Pre-exercise USG (gr/cm^3)	1.016 ± 4.10	1.002-1.022
After Exercise USG (gr/cm^3)	1.024 ± 3.10	1.018-1.030
Pre-sauna USG (gr/cm^3)	1.016 ± 4.33	1.002-1.022
After Sauna USG (gr/cm^3)	1.022 ± 3.05	1.018-1.032

Table 3. Quantity Fluid Loss of the Tennis Players (n: 35)

	$\bar{x}$-ss	min-max
BW loss by Exercise (kg)	1.73 ± 0.54	1.00-3.20
BW loss by Sauna (kg)	1.43 ± 0.42	0.50-2.50
BW% Loss by Exercise	2.45 ± 0.74	1.45- 4.59
BW% Loss by Sauna	2.01 ± 0.56	0.78-3.57

Dehydration Status of Tennis Players (n:35)

The dehydration status of tennis players is shown in Table 4. The dehydration status of the athletes was determined and the T-test was applied to samples independent of statistical tests between pre-post exercise, pre-post sauna, exercise BW loss-sauna BW loss, post-exercise post-sauna USG, pre-exercise-pre-sauna USG values. As a result of the statistical evaluation, the athletes before and after exercise; There was a significant difference between USG values before and after sauna ($p < 0.01$). There was a significant difference between exercise BW loss and sauna BW loss of athletes ($p < 0.01$). In addition to that, there was no significant difference between post-exercise and post-sauna USG values of athletes ($p < 0.01$). There was no significant difference between pre-exercise and pre-sauna USG values of athletes ($p < 0.01$).

Table 4. T-test results of Dehydration Status in Tennis Players (n:35)

	t	p
Pre exercise-post exercise USG (gr/cm^3)	-14.48	0.00**
Pre sauna-post sauna USG (gr/cm3)	-11.74	0.00**
Post Exercise-Post Sauna BW (kg)	3.76	0.00**
Pre-exercise- Pre sauna USG (gr/cm^3)	0.25	0.81
Post Exercise- Post Sauna USG (gr/cm^3)	1.47	0.15

**($p<0.01$)

DISCUSSION

The main reason for scientific studies in training science is to obtain maximal training potential and gain peak competitive performance in sports. One of the major preventive factors that could degrade the peak performance in tennis is to keep the hydration state under control for preventing the effects of fluid loss from decreasing performance. By examining the dehydration status of athletes in different methods and different exercise intensities, the researcher tried to measure and evaluate the loss quantity and effects of the hydration status. Studies have shown that dehydration differs in terms of exercise intensity and individual differences (25-29). In the current study, how much dehydration tennis players are exposed to as a result of aerobic exercise was investigated; and an exercise with 60% intensity, considering the average number of heartbeats of tennis matches. Since there is no time limitation in tennis matches, 90 minutes of running was organized considering the longest time that can be done in the laboratory environment.Casa et al. (2000)(30) conducted a graded dehydration classification study. The study categorized the urine density (USG) 1.010-1.020 g/cm^3 and/or -1 to -3% BW change as minimal and 1.021-1.030 g/cm^3 and -3 to -5 as significant or moderate dehydration status respectively. According to USG values measured as 1.024 ± 3.10 g/cm^3 after exercise and 1.022 ± 0.5 g/cm^3 after sauna shows that there is dehydration above the minimal level (Table 2).Some studies support the findings of the current study for exercise-induced dehydration results (31) and those that do not (9,32). For instance, the mean fluid loss by exercise in BW of the present study was 1.73 ± 0.54 kg and 2.45 ± 0.74%, fluid loss of the endurance-trained males (25 ± 5 years; 175 ± 5 cm; 70.35 ± 5.46 kg; VO2max, 62.95 ± 7.20 ml/kg/min−1) in [33] percentage change in the BW (2.43±0.59%1.71±0.46 kg) results were parallel with the present study (Table 3).

Tennis players lost 1.73 ± 0.54 kg and 2.45 ± 0.74% of their total BW in total of 90 minutes in 60% intensity exercise in this study (Table 3). The results demonstrated that both of the study BW losses differed proportionally but the range of the % BW loss was similar according to the Casa et al (2000)(30) classification (minimal dehydration ranges = -1 to -3% BW loss). When the results of this study were compared with the study of Irwin et al., (2017)(33) It was seen that the proportional BW loss was low, while the BW loss was high when evaluated as kg. This suggests that exercise duration and intensity increase total BW loss, but do not have the same effect on proportional fluid loss.There were also the dehydration studies with fluid intake parallel with the current study results. López-Samanes et al. (2018)(31) examined the hydration status of tennis players during the match conditions. Hypohydrated (USG = 1.026 ± 0.002) tennis players lost 1.0 ± 0.3% of BW in spite of 1.035 ± 0.124 L/h of fluid ingestion. In the present study, the dehydration value (USG) without fluid intake was 1.024 ± 3.10 gr/cm^3 and the BW loss was 1.73 ± 0.54 kg (Table 3). The reason for the higher value of BW loss in the current study than López-Samanes et al. [32] study may be the exercising protocol that was applied without fluid intake in the current study. Both of the studies demonstrated that despite the difference in exercise protocol and match condition with and without fluid intake, similar changes in BW and % fluid loss values were observed. Another study in a similar way, taking fluid Ito et al. (2020) examined the effect of electrolyzed hydrogen water on dehydration and triathlon athlete performance. In the study, the athletes exercised 65% of their VO2max for 1 hour and took 2ml/kg of fluid every 15 minutes. It was stated that electrolyzed hydrogen water did not change the athlete's performance and body fluid balance, but reduced energy consumption. In the study, an average of 1.1 ± 0.4 kg BW loss was observed despite fluid intake during 1 hour of exercise. tennis players exercised for 90 minutes without fluid intake and a loss of 1.73 ± 0.54 kg (2.45 ± 0.74 %) was determined (Table 3). Another study investigating the physiological responses of tennis players on different grounds, despite fluid intake, an average of 1.05 ± 0.49 % BW loss was observed on the hardcourt and 0.32 ± 0.56% on the clay court. Before the match, the mean USG value of athletes' clay and hard courts were measured as 1.022 ± 0.004 (9) (USG value 1.020 is considered normal hydration (30)). The study also shows similar USG results on different court measurements. Indeed, these scientific studies show that for the evaluability and interpretation of the findings, controlled studies should be carried out on how much fluid loss will affect hydration when the athlete does or does not take fluids during match and laboratory conditions.Athletes dehydrate in different amounts depending on many variables such as the duration of the sauna, body composition, routine sauna activity in research studies. [10,33,34] Researchers have also investigated the effects of sauna-induced dehydration on athletes. In the study of Gutierrez et al. (2003), three-period sauna of 20 minutes at intervals of 5 minutes were applied to male athletes to evaluate the rapid weight loss of athletes. In the mentioned study, the athletes' BW loss result 1.40 kg (1.8 ± 0.5%) was similar to the current study 1.43 kg (2.01 ± 0.56%).In the study of Podstawski et al, (2014) sedentary participants were taken to the sauna with 5-minute breaks and two times of 10-minute periods, the participants lost an average of 0.42 ± 0.14 kg from their BW. Similarly, in the Podstawski et al. study (2019) the sedentary participants were kept for 40 minutes with 5-minute breaks, the participants lost an average of 0.65 ± 0.24 kg from their BW. Moreover, participants were allowed to enter the pool and take a shower with 14-15 degrees water during breaks. Due to the difference in the study design, no application to reduce body temperature was applied to tennis players in the present study might be the result of the less BW (1.43 ± 0.42 kg) loss in this study (Table 3). Since USG values were not examined in the study, the hydration status was not compared. The BW loss results of studies (33,34) were parallel with the current study. In contrast to the above-mentioned study, Hornery study (2007)(9) it is stated that their body temperature increased due to lack of thermoregulation. Therefore, less fluid loss was observed compared to the present study. This situation is thought to be caused by the athletes starting the match dehydrated.

Conclusions and recommendations

It is a good strategy for athletes to monitor body weight before training sessions or competitions, to maintain proper hydration. Moreover, monitoring the color of urine is a simple way to assess the hydration status. However, the American College of Sports Medicine (ACSM) warns that urine color may be misleading about the hydration status.

The findings of the research are guiding in terms of dehydration comparison for athletes, coaches, conditioners, and sports scientists. For future studies and to prevent dehydration, fluid and electrolyte loss should be determined using ergogenic assistance. The study offers the opportunity to compare the sauna practices and hydration conditions of athletes.

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