Estimation of urinary 24-hour sodium excretion in young Saudi professional soccer players

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Abstract

Aim: to estimate 24-hour urinary sodium concentration in young Saudi professional soccer players by using a single spot urine. Method: a cross sectional study design, conducted during the official Saudi Soccer League 2015/2016. A total of 25 players from Riyadh, Saudi Arabia participated in this study. Age, weight, height, body fat % and single urine sample were collected pre-training day. Sodium (Na) and creatinine (Cr) were analyzed. Estimation of 24-hour sodium and creatinine were calculated by the Kawasaki formula: $16.3 \times$ [spot urine Na (mmol/l)/spot urine Cr (mmol/l) $\times$ estimated 24-hour urinary Cr (mg)$^{0.5}$, and $-4.72 \times$ age $+ 8.58 \times$ weight (kg) $+ 5.09 \times$ height (cm) $- 79.9$. A descriptive and Pearson correlation data analysis were used. Result: estimation of 24h sodium (27.1 mEq/L/24h) was lower than reference range. Strong relationship between anthropometric measurements (i.e., weight, height, % body fat) creatinine 24-h estimation. Age shows a strong relationship with sodium. The current study found a poor of estimation for 24-h urinary sodium concentration by using a single spot urine among soccer players. Conclusion: using single spot urine has shown a poor estimation of sodium in athletes population. However, future studies for collection of multiple spot urine samples methods in the estimation of 24-h urine Na is warranted.

Keywords: Sodium, Spot urine, Dehydration, Electrolytes.

INTRODUCTION

Electrolyte balance has been considered important in the maintenance of normal physiological and biochemical functioning during exercise and competition. In endurance exercise, production of heat and muscular contractions lead to sweating which helps the thermoregulation system to maintain a normal body temperature[1]. Excessive sweat loss and poor dietary intake is related to a decrease in performance and may affect electrolyte hemostasis. Sodium (Na) is the essential electrolyte in the amount of total body water, sweat and muscles contraction[2,3]. However, excessive sodium intake is associated with elevation of blood pressure and greater risk of cardiovascular disease[4]. Studies suggested that 24-hour urinary excretion, when complete, contains about 90% of sodium consumed from all sources daily dietary and fluid intake[5].

In the evaluation and measurement of sodium excretion, a 24-hour urine analysis is considered the most reliable method[6]. However, a spot urine (SU) sample analysis is a more practical method and several methods of 24-hour urine sodium estimation derived from an SU sample have been developed and used as an alternative to a 24-hour urine collection method[7–9]. Moreover, a SU sample is an easier method than collecting total urine for an entire day, which is problematic and cumbersome for most people. Still, more studies need to address 24-hour urinary sodium in specific athlete populations.

Studies that have used SU samples in athletes are limited. Evaluating and measuring the 24-h urine sodium extraction in athletes using SU will help establish more practical methods to assess the concentration of sodium in the body for athletes. To date, no research has been reported on the estimation of 24-hour urinary sodium in Saudi soccer players. To our knowledge, no study has been conducted to estimate 24-hour urinary sodium or has evaluated the hydration status for Saudi soccer players during activity in warm environmental conditions. The purpose of this study is to estimate a single SU 24-h urinary sodium of young Saudi professional soccer players.

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METHODOLOGY

A cross-sectional design was used for this study, which was conducted in Riyadh, Saudi Arabia. Ethical approval was obtained from King Saud University (4/67/352673), and the purpose, protocol and procedure for this study were explained to all players before starting the study. Written consent was obtained from the participants after which they were informed of the purpose, procedure, and risks of participating in the study.

Participants

A total of 25 Saudi young professional soccer players were recruited to participate in this study. All players normally train five days and play a match once a week during the official Saudi Soccer League 2015/2016 (mean±: age 20.16 ± 0.85 years, body weight 66.21 ± 5.3 kg, height 175 ± 4.3 cm, body fat % 6.72 ± 2.12).

Anthropometry measurements

Participants' body weight was measured with a digital scale to nearest 0.1 kg (Seca 813, Germany), and height was obtained to the nearest 0.01 cm (Seca 213, Germany). The body fat percentage was measured using skinfold thickness at four sites: suprailiac, abdominal, thigh and triceps using Holtain skinfold caliper to measure the skinfold (Holtain Ltd., Crymych, UK). The sum of four measurements of skinfolds was used to estimate % body fat using the following equation [10]: body fat percentage = (0.29288 x sum of skinfolds) – (0.0005 x square of the sum of skinfolds) + (0.15845 x age) – 5.76377[10].

Urine sample collection

Spot urine samples were collected from soccer players. Urine samples were provided by each player from midstream two hours before training sessions began on the day designated for measurements. The urine samples were collected in a 30 ml sterile tube. Each tube was labeled according to the code of players' numbers and stored in a cool container before being transferred to a biochemistry lab at King Saud University for the analysis.

Urine sodium and creatinine analysis

The analyses were run for sodium and creatinine using intergraded multisensor technology (IMT) (Siemens Dimension Xpand Plus, Germany). A diagnostic test was used to measure the concentrations of sodium and creatinine in the urine samples using Siemens reagent (Siemens QuikLYTE® Integrated Multisensor). The volume requirement of 500 µl was pipetted in the small cup and inserted in the special rack to complete the test. In addition, the instrument was calibrated daily in the early morning using quality control processes.

Urinary estimation of 24-HUNa from SU samples (Sodium and Creatinine)

Estimation of sodium and creatinine in the 24 h was calculated by Kawasaki formula which is valid to assess the level of urinary sodium and creatinine in the following equations:

Estimation of 24 h urinary sodium excretion mmol/24h:[7]

$16.3 \times$ [spot urine Na (mmol/l)/spot urine Cr (mmol/l) $\times$ estimated 24-hour urinary Cr (mg)$^{0.5}$

Estimation 24-hour urinary creatinine excretion, mg/24 h:[11]

Men : $-4.72 \times$ age $+ 8.58 \times$ weight (kg) $+ 5.09 \times$ height (cm) $– 79.9$

Statistical analysis

A descriptive analysis of the data was used and reported as mean and standard deviation. A Pearson correlation coefficient was used to examine the relationship between spot urine sodium (SUNa) / spot urine creatinine (SUCr) and 24-HUNa/24HUCr. A significance level ≤ 0.05 was considered statistically significant. All data analysis was carried out using IBM's SPSS version 27 (version 27 SPSS, Inc. Chicago, Illinois).

RESULTS

Results are presented for the total of 25 participants, aged between 19 and 22 years old. A summary of the participants' characteristics (e.g., age, weight, height, body fat %), sodium (mEq/L), creatinine (mg), 24-h estimation sodium (mEq/L/24h), and 24-h estimation creatinine (mg/24h) is presented in Table 1.

A correlation analysis of SUNa/SUCr against 24-HUNa/24-HUCr and other variables are presented in Table 2. The correlation showed no relationship between estimated SUNa and SUCr. However, an estimation of 24h SUNa shows a relationship with age (-0.553) and a 24h estimation of SUCr revealed a relationship with SUCr and weight (0.966), height (0.541) and body fat % (0.645).

Table 1: Characteristics of the sample population Mean ± SD (minimum-maximum)

Variable	Mean ± SD	Min/Max
Age (years)	20.16±0.85	(19 – 22)
Height (cm)	1.75±0.043	(1.63 – 1.82)
Weight (kg)	66.21±5.3	(55.1 – 73.70)
Body Fat (%)	6.72±2.12	(3.90 – 13.70)
Sodium (mmol/L)	104.84±49.68	(25 – 196)
Creatinine (mg)	328.96±145.19	(88.93 – 619.32)
Creatinine mg/24h	407.41±44.76	(312.82 – 472.40)
Sodium mmol/24h	27.1±11.31	(9.39 – 55.95)

Table 2: Correlation coefficients of study variables for 25 participants

Variable	1	2	3	4	5	6	7	8
1.Age (years)	--							
2. Weight (kg)	0.236	--						
3. Height (cm)	0.165	0.543[**]	--					
4. Body Fat (%)	0.148	0.647[**]	0.324	--				
5. Sodium (mmol/l)	-0.553[**]	-0.287	-0.084	-0.268	--			
6. Creatinine (mg)	-0.223	-0.019	0.214	-0.296	0.096	--		
7. Sodium mmol/24h	-0.069	-0.015	-0.364	0.200	0.292	-0.783[**]	--	
8. Creatinine mg/24h	0.151	0.996[**]	0.541[**]	0.645[**]	-0.242	0.001	-0.011	--

Note: $*p < .05$, $**p < .01$, two-tailed.

DISCUSSION

It is known that electrolyte concentration is affected by the daily dietary intake[12]. Thus, dietary intake plays a role in the maintenance of normal electrolyte concentration in the human body[13]. In addition, the estimation of urinary sodium concentration in the general population has been studied[14,15]. However, to our knowledge there is no study of estimated urinary sodium and creatinine in athletes. Therefore, the current study aimed to estimate the urinary sodium and creatinine concentrations from one spot urine test in a sample of young professional soccer players living in hot weather in Saudi Arabia.

It is known that sodium balance plays a role in the maintenance of fluid balance and is significantly involved in muscle contraction[16–18]. A high training load[19] and intensive endurance exercise[20] have been shown to impact the volume of sweat loss, especially in warm or hot weather conditions. Therefore, excessive sweat loss remains a main factor and reason for heat cramps during exercise due to dehydration and a low level of sodium in the body[21,22]. Meanwhile, dehydration combines with sodium depletion in the muscle which can lead to fatigue during exercise[21]. Optimal sodium intake with fluid intake strategies can increase and maintain total body hydration, and even preserve homeostasis of fluid during long and intense training in hot weather conditions. Moreover, measurement of creatinine excretion is associated with sodium concentration and calculating the ratio of sodium and creatinine may lower the accuracy of value in the spot urine test[23].

Meanwhile, calculation of estimation of SUNa/24h cannot be completed unless creatinine concentration is added. Thus, in the current study the measurement of creatinine 328.96 (mg) is lower than the reference range (500 to 2000 per day).

In the current study, sodium was associated with the age of players which replicates previous studies conducted on the general population[24]. Furthermore, previous studies have demonstrated that younger people, especially of the male gender, have an inadequately healthy dietary intake[25,26]. As the unique population in the current study is both young and male, it is assumed that poor dietary intake and low levels of hydration are linked to low sodium concentration in our sample. On the other hand, the estimation of sodium intake by SUNa/24h or a single urine sample collection might not show the present level of sodium concentration during the day for soccer players.

Urinary sodium ranges between 40 and 220 mEq/L in a normal sample of urine for adults. The current results of this study revealed that the measurement of sodium of spot urine were at the optimal level. However, results found that when referring to the estimation of SUNa/24, the value was less than the normal references range. Consequently, as collection of spot urine samples are low in cost and feasible with minimum effort they may be particularly of use with athletes. On the other hand, it is not recommended to assess sodium intake or concentrations in urine due to sodium excretion during the day[5]. Therefore, estimation of SUNa/24h could be inaccurate in the evaluation of the sodium intake of athletes.

CONCLUSION

Estimating urinary sodium from spot samples using the Kawasaki formula has been validated in different studies when compared with 24h urine sample collection. However, estimation of sodium of spot urine should be taken with high precision especially with athletes due to excessive sweating and exposure to exercise in hot weather conditions.

Conflict of interest

The author declares no conflicts of interest

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