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Urinary parameters' evolution during junior male water polo microcycle training

Evoluția unor parametri urinari pe parcursul unui microciclu de antrenament în cadrul unei echipe masculine de polo juniori

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Abstract

Background. Urinary parameters analysis in water polo players can be influenced by specific training evolution.

Aim. The aim of the study was to evaluate the main urinary parameters that can determine physical activity changes in a group of male athletes.

Methods. A cross sectional study was conducted in Tîrgu Mureş, Romania between 6th of November and 8th of January 2018, on a group consisting of 14 male water polo players, aged 13 years old, enrolled in national competitions. In order to determine urine density and urinary pH values, urinary sample collection was required, both at the beginning and at the end of the training session. Urine density and urinary pH were assessed using urinary Cybow strips.

Results. Statistically significant differences regarding urinary parameters and water polo training periodization were recorded. Thus, both urinary pH values, determined both before (p=0.0001, r=-0.7451, 95%CI =-0.8416 to -0.6023) and at the end (p=0.0467, r=-0.2557, 95%CI =-0.4827 to 0.003541) of the training session indicated low values when high urinary density was associated. Also, a decrease in urinary pH values was associated with a high urinary density determined at the end of the physical effort (p=0.0231, r=-0.2906, 95%CI =-0.5111 to -0.03418).

Conclusions. The main urinary parameters, urine density and urinary pH, recorded significant statistical changes related to the performed physical effort. An elevated urinary density value indicated a specific dehydration state, also evidenced by a low urinary pH value.

Keywords: pH, density, water polo

Rezumat

Premize. Parametrii urinari ai jucătorilor de polo ar putea fi influențați de periodizarea specifică a antrenamentului sportiv.

Obiective. Ne-am propus să studiem principalii parametri urinari capabili să determine modificări ale performanței sportive, în cadrul unei echipe masculine de polo.

Metode. A fost desfășurat un studiu transversal observațional, în perioada 6 noiembrie 2017 - 8 ianuarie 2018, pe un grup format din 14 jucători de polo, cu vârsta de 13 ani, care activează în cadrul competițiilor naționale. În vederea determinării densității și pH-ului urinar a fost necesară prelevarea probelor de urină, atât pre-efort sportiv, cât și post-efort sportiv. Analiza densității și pH-ului urinar a fost realizată prin utilizarea stripurilor urinare Cybow.

Rezultate. S-au identificat diferenţe semnificativ statistice privind parametrii urinari şi periodizarea antrenamentului sportiv. Astfel, ambele valori ale pH-ului urinar, determinate atât înainte (p=0,0001, r=-0,7451, CI95%=-0,8416 la -0,6023), cât şi la sfârşitul (p=0,0467, r=-0,2557, CI95%=-0,4827 la 0,003541) şedinţei de pregătire au înregistrat valori scăzute în momentul asocierii cu valori crescute ale densității urinare. De asemenea, o scădere a valorilor pH-ului urinar a fost asociată cu creşterea densității urinare determinate după finalizarea antrenamentului sportiv (p=0,0231, r=-0,2906, CI95%=-0,5111 la -0,03418).

Concluzii. Determinarea densității și pH-ului urinar a generat modificări importante în asocierea efortului sportiv. Obținerea valorilor scăzute în cadrul pH-ului urinar a determinat creșterea densității urinare, indicând o stare de deshidratare a tinerilor sportivi.

Cuvinte cheie: pH, densitate, polo

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Introduction

Water polo represents a competitive team sport which combines swimming technique with appropriate ball handling. The competition effort is intermittent, athletes' heart rate measuring 75-90% of HR_{max}. The usual distance reached during a competition varies between 1500-1800 m (Snyder, 2008).

Recovery actions between training sessions, along with rest periods, daily activity, food consumption and liquid intake are the main influencing factors of sports performance. The water distribution in the body, illustrated by Cornish BH, Ward LC, Thomas BJ et al., varies with age, gender and body composition. However, the human body has a variable amount of water, estimated at 50-80% of the total body mass (Cornish et al., 1996).

According to Baker LB, Reimel AJ, Sopeña BC et al., fluid needs are assessed based on the effort performed, its duration, and the effort conditions such as water temperature (Baker et al., 2017; Baker, 2017; Martin & Tarcea, 2914). Thereby, undertaking most of the training in water can make it difficult to estimate the amount of water lost by athletes (Cox et al., 2014).

The hydration status can be determined by weighing the athletes both before and after the effort, taking into account the fluid intake during training (Cox et al., 2014). However, a more accurate method in determining hydric status involves the use of various physical (density, color, urinary volume) and chemical urinary parameters. Thus, recent studies emphasize the use of urine density as a standard parameter in order to assess the fluid ingestion/ excretion ratio. There is a link between fluid loss and urine color intensity, along with the dilution and the quantity of urine (Dumitrașcu et al., 2005). However, the chemical nature of urine is used to analyze the acid-base balance and pH homeostasis. Therefore, sustained physical activity can generate pH variations, and especially a temporary pH decrease (Welchet al., 2008). Thus, in order to have a full understanding of the acid-base balance and electrolytic deficiencies regarding fluid losses, determination of urinary parameters is required (Seifter & Chang, 2017).

Hypothesis

The aim of the study is to identify the main training parameters that can generate urinary changes (both physical and chemical) and major changes in the hydration status.

Material and method

Research protocol

A cross sectional study was conducted after obtaining a verbal acceptance from the athletes, the written consent of the subjects' legal guardians and a written approval from the administration office.

a) Period and place of the research

We conducted the study in Tîrgu Mureș, Romania, between 6th of November 2017 and 8th of January 2018, in an Olympic swimming pool sports complex.

b) Subjects and groups

The sample included 14 male subjects with a median age of 13 years (between 13 and 14 years) enrolled in a water polo team, with active participation in national competitions. Only healthy subjects were included in the study due to pH characteristics, whose values can be influenced by pathological conditions. The analyses were performed during the specific training cycle of the athletes.

c) Test applied

Urinary sample collection was performed, and urine density (kg/m^3) and urinary pH were analyzed in relation to physical activity. Urine samples were collected in sterile containers before and after the training session. The urine samples were taken within 5 minutes before the start and the end of training. The assessment of both urinary pH and urine density was performed using urinary Cybow strips (Gimhae, South Korea).

Through anthropometric measurements, we determined the height (m), weight (kg), body mass index (BMI), skeletal muscle percentage (%) and body fat percentage (%) of the study group, on 6th of November 2017, using the Omron BF511 (Kyoto, Japan) body composition scale. At the same time, within the study, the training program of the athletes was monitored, including parameters such as effort intensity (% HR_{max}), volume (meters) and total training time (minutes).

d) Statistical processing

Statistical analyses were performed using GraphPad Prism 6.0 software. The main descriptive indicators used were: mean, median, standard deviation (±SD) and coefficient of variation (CV%). The tests applied for inferential statistics were: the D'Agostino-Pearson normality test for data normalization, the Spearman rank correlation test to establish the association between two items, and the Wilcoxon matched pairs test to establish if there were differences between two measurements. The confidence interval was set at 95% (95% CI), a p value smaller than 0.05 being considered significant.

Results

The median age of the study group was 13 years (CV 3.78%). The anthropometric report registered a median height value of 1.70 m with values between 1.51 and 1.79 m, along with 68 kg body weight with values ranging between 36.9 and 86.5 kg.

An increased body weight was associated with elevated urinary density, recorded at the end of the training session (p=0.0019, r=0.3899, 95%CI=0.1456 to 0.5894). However, we did not identify an increase in urinary pH after training, whose value was 5, as shown in Table I.

Table I

Statistical correlations between body weight, density and urinary pH

Body weight (68 kg)		
Reported data	Post density (kg/m^3)	Post pH
Median	1.03	5
p	0.0019	0.0425
r	0.3899	-0.2606
95% Confidence Interval Lower	0.1456	-0.4867
95% Confidence Interval Upper	0.5894	-0.001725

The total fat mass percentage (20.8%) developed a significant statistical relationship with the urinary density determined at the end of the practice session (p=0.0195, r=0.2984, 95%CI =0.04269 to 0.5174). The analysis

Table II

Statistical correlations between body fat, skeletal muscle, body mass index and the analyzed parameters

Body fat (20.8%)				
Reported data	Skeletal muscle (%)	BMI	Pre density (kg/m^3)	Post density (kg/m^3)
Median	37.4	23.52	1.025	1.03
p	0.0001	0.0001	0.0836	0.0195
r	-0.7957	0.7677	0.2234	0.2984
95% Confidence Interval Lower	-0.8745	0.6350	-0.03781	0.04269
95% Confidence Interval Upper	-0.6761	0.8564	0.4560	0.5174

BMI (23.52)		
Reported data	Pre density (kg/m^3)	Post density (kg/m^3)
Median	1.025	1.03
p	0.0353	0.0014
r	0.27	0.4008
95% Confidence Interval Lower	0.01185	0.1583
95% Confidence Interval Upper	0.4944	0.5978

revealed that pre-effort urinary density (1.025 kg/m^3) was not significantly correlated with the athletes' body fat percentage (p=0.0836, r=0.2234, 95%CI =-0.03781 to 0.4560). Furthermore, an increase in the athletes' BMI was significantly associated with an increase in urinary density values, determined both before (1.025 kg/m^3) and after training (1.03 kg/m^3), according to the data presented in Table II.

The urinary parameters determined both before and at the end of the training session were significantly correlated with the training intensity and volume. Thus, an increased urinary density before training (1.025 kg/m^3) generated an elevated urinary density value at the end of the physical effort (1.03 kg/m^3). Both urinary pH values, determined before (pH=6) and after (pH=5) physical activity, indicated low values in association with high urinary density (1.025 kg/m^3) (p=0.0001). Also, an increased value of urinary density determined post-effort (1.03 kg/m^3) was related to a urinary pH decrease, before (pH=6) and after the training session (pH=5). However, an increased effort intensity was associated with a low urinary pH value (pH=5) at the end of physical activity, as shown in Table III.

Table III

Correlations between urinary parameters

Pre density (kg/m^3)			
Reported data	Post density (kg/m^3)	Pre pH	Post pH
Median	1.03 kg/m^3	6	5
p	0.0008	0.0001	0.0467
r	0.4175	-0.7451	-0.2557
95% Confidence Interval Lower	0.1777	-0.8416	-0.4827
95% Confidence Interval Upper	0.6105	-0.6023	0.003541

Post density (kg/m^3)		
Reported data	Pre pH	Post pH
Median	6	5
p	0.0001	0.0231
r	-0.5086	-0.2906
Confidence Interval 95% Lower	-0.6782	-0.5111
Confidence Interval 95% Upper	-0.2874	-0.03418

Post pH (5)	
Reported data	Effort intensity (%)
Median	50
p	0.033
r	0.2735
95% Confidence Interval Lower	0.01557
95% Confidence Interval Upper	0.4972

Discussion

Physical effort can generate variations in urinary density and pH. According to Ilyas R, Chow K, Young JG, the use of urinary strips in pH determination could have similar results to those analyzed using a pH-meter. However, the dipstick method is not reliable in making clinical decisions (Ilyas et al., 2015; Kwong et al., 2013). According to Aspevall O, Hallander H, Gant V et al., the pH test is related to color reactions such as methyl red, bromothymol blue and phenolphthalein. Thus, a pH value between 5 and 9 represented a color gradation from orange to yellow-green and blue. A urinary pH was considered to be acid at a value of 5, with the possibility to drop below 4.8 in fever conditions, diarrhea or metabolic acidosis. An alkaline urinary pH was considered when its value was above 7.4. The urine density test compares urine density with distilled water density, which has a value of 1.000[2]. The tests related to urinary ionic concentrations, whereas the cationic establishment generated color changes in the urinary strips. The reference value used was between 1.000 and 1.040 kg/m^3 (Aspevall et al., 2001).

Urine density depends on the fluid that was consumed before the evaluation (Aspevall et al., 2001). Thus, under physiological conditions, the excreted urine quantity is inversely proportional to urine density (Dumitrașcu et al., 2005). In the study group, there were differences between the urine density values determined at the beginning of training (1.025 kg/m^3) and the results obtained at the end of the session (1.03 kg/m^3). An increased urinary density value can confirm the dehydration state of the athletes. Furthermore, the hypothesis advanced by Reale R, Slater G, Dunican IC et al. confirms similar results, where the dehydration process determines variations in urinary density, fluid and electrolyte losses (Reale et al., 2017). The study conducted by Judelson DA, Maresh CM, Anderson JM et al. suggests a negative change in the athletes' performance by a reduction of muscular power and strength due to insufficient fluid intake, along with urine density and pH changes (Reale et al., 2017; Judelson et al., 2007). Thereby, based on similar findings, we can confirm that fluid intake will have an impact on the athletes' evolution, regardless of the training sessions and competitions.

Water and electrolyte balance is a representative element as it must be maintained due to the fact that blood and urine pH is modified according to physical activities. Thus, the body pH reduction can be influenced by developing a mixed anaerobic effort (pH post-physical effort=5), which confirms current results that describe a urinary pH response related to effort intensity (Petrushova & Mikulyak, 2014).

Conclusions

1. In the study group, we reported significant statistical variations in urinary pH and density related to anthropometric evolution and the physical activity performed.

2. According to anthropometric data, subjects with an increased body weight, BMI and body fat mass had significant changes in post-effort urine density. Thereby, we believe that these subjects are likely to have a higher dehydration rate than athletes with lower anthropometric values.

3. An inadequate fluid intake was highlighted by obtaining an acid urinary pH due to an increased value of pre-effort urine density. A certain dehydration state of athletes at the beginning of the training session was justified by a high pre-effort urinary density value.

4. The intensity of the physical effort performed was able to generate changes in urinary pH.

Conflicts of interest

There are no conflicts of interest regarding the study group, methodology, results and conclusions drawn.

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