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Comparison of body hydration status before and after training in male rugby seven players in cool and warm environment

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Abstract

Background and Study Aim. The impact of natural alternation of seasons on hydration status in athletes is not known, but it is a factor influencing efficiency of the training. The aim of our investigation was to compare pre- and post- training body hydration status, a body mass (BM) changes and sweating rate in male rugby seven players in early spring and summer.

Material and Methods. Twenty four male rugby seven players participated: 13 players in March (air temperature: +4**°C,** humidity 65%), 13- in June (air temperature: +19°C, humidity 70%). The pre- and post-training urine samples were collected. Players with urine specific gravity (USG) ≤1.020 were "euhydrated", with USG 1.021-1.030 "hypohydrated", with USG >1.030 "seriously hypohydrated". Sweating intensity was calculated from the BM changes, consumed water mass, urine volume and the duration of training.

Results. The mean pre-training USG in cool environment was in norm: 1.019±0.008, but in warm conditions exceeded the boundary of norm: 1.021±0.005. The mean USG after training indicated similar hypohydration in spring and summer. The mean BM did not significantly decreased after training in cool and warm environment. Decrease of the BM >2% was observed in two athletes and for 1.5-2 % in six players only in cool conditions.

Conclusion. Fluid consumption in cool conditions was insufficient in preventing the body hydration status worsening and a decrease in BM for more than 1.5-2% in some players. The fluid consumption in warm environment better allows prevent the body hypohydration and keep the BM decrease below 1.5%.

Key words: rugby seven • sweating intensity • urine specific gravity

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Introduction

The level of body hydration determines the aerobic capacity and psychomotor performance of athletes [1]. For example, a moderate dehydration (water loss that causes the body mass decrease by 1.5–2%) significantly reduces the physical performance and psychological condition of soccer players [2]. Pre-exercise hypohydration may result in a lower sweat rate, a more rapid rise in core body temperature and higher heart rate during workout [3, 4]. Therefore keeping the degree of dehydration within the acceptable limit lower than 2% of the body mass loss during a play match or training session may be not possible if the sport games players begin exercise in a hypohydrated state. Hence, pre-training body hydration status in rugby players should considered an important factor potentially influencing efficacy of training.

The performance of athletes is remarkably influenced by dehydration of body, which is especially important in sports where the performance lasts longer than an hour, including sports games, for example, in summertime about 0.99 – 1.93 litres of fluid (mean 1.46 litres) are lost by every soccer player during a training, whereas during a training in winter 0.71-1.77 (mean 1.13) litres of fluid are lost [5]. Loss of fluid during the training or a game is significantly influenced by the environmental factors, especially in case of outdoor sports activities (soccer, rugby) which take place in an open stadium. Therefore the sweating intensity of soccer and rugby players changes according to the weather: the air temperature, humidity and wind flow velocity. The studies providing direct comparison of pre-and post- practice body hydration status in sport games players training in different environmental conditions due to natural alternation of seasons are investigated only in limited number of investigations. For example [5], investigated and compared fluid loss by sweating in soccer and basketball players in summer and winter.

Fluid intake cannot be based solely on the subjective thirst sensation of athletes because thirst appears only after the body mass loss by 1-2% by sweating from pre- training mass. So, if fluid consumption is based only on thirst sensation, large body mass decrease will appear and considerably influence the performance of athletes [6].

Therefore it is necessary to choose method for determination of body hydration status that can be used in field conditions and give opportunity to describe body hydration status sufficiently precisely. Determination of urine specific gravity fits those criteria. It has been widely recognised that urine specific gravity (USG) over 1.020 is associated with hypohydration and USG over 1.030 is associated with seriously hypohydration of the body, referring to data provided by the American Medical Society for Sports Medicine [5] and National Collegiate Athletic Association [7]. Urine specific gravity can be determined by using three methods of fast evaluation: hydrometry, refractometry and reagent test strips. Stuempfle & Drury [8] compared the accuracy of these methods by testing representatives of wrestlers before and during competition and found refractometry to be the only accurate method to determine the urine specific gravity; in case of hydrometry 28% of results were false positive, 2% – false negative, but in case of reagent test strips (15% of results were false positive, 9% – false negative).

The aim of our investigation was to compare pre- and post- training body hydration status, a body mass changes and sweating rate in well trained male rugby seven players in early spring and summer.

Material and Methods

Participants

Twenty four male rugby seven players from the same team of the Premium League voluntary participated in our study. Two athletes from 24 participated in our investigation in moderate (early spring) and in warm (summer) environment. The investigation protocol was approved by the Ethics Comity of Latvian Academy of Sports Education. The players mean age was 26.19 ± 4.95 years. They had the mean training experience in rugby seven of 11.7 ±7.8 years and had regular trainings or play matches with duration of 2,0 ±0.7 hours four times per week (8.2 ±3.4 training hours per week).

Study design

We determined usually pre- and post- training body hydration status in well trained male rugby seven players in cool and warm environment. Therefore we asked the participants to consume the fluid as they usually do according to their subjective thirst sensation and not change their drinking habits before training and during it. The training duration was 1.5 hours in cool and in warm environment. All water bottles of every player were weighted before and after training by using of special scales Midrics1 (Sartorius, Germany) with precision of 0.01 kilogram. The urine produced by athletes after training was weighted by the same scales. The pre- and post-training urine samples of rugby seven players were collected within one day at the fourth week of March (the air temperature in that day was +4**°C, humidity 65%, without rain**

and the speed of wind 2 meters per second) and in the end of June (the air temperature in that day was +19°C, humidity 35%, without rain and wind).

Sweating intensity of every rugby players was calculated from the data of the body mass changes, consumed water mass, urine volume produced after training and the duration of training, taking into account that 1kg of water = 1 liter of water [9]:

Sweat rate (l/h) = {[pre-practice mass (kg) – post-practice mass (kg)] – post-practice urine volume (l) + fluids consumed during practice (l)}/ length of practice session (h).

Anthropometry and body composition analysis

Athlete's height was measured by Ultrasound Height Measuring Unit MZ10020 (ADE, Hamburg). Body mass was measured wearing briefs by special scales Midrics1 (Sartorius, Germany) with precision of 0.01 kilogram before and after training. Body fat percentage and total body water content in percents were measured using Body Composition Analyzer BC-418 manufactured by Tanita Corporation, Japan. Rugby players' body surface area (BSA) was calculated using the equation [10]:

$$BSA\ (m^2) = 0.20247 \cdot height\ (m)^{0.725} \cdot body\ mass\ (kg)^{0.425}.$$

Urine sampling and analysis

Before and immediately after training, participants provided a midstream urine sample into a sterile polyurethane container (15 ml, Sarsted Aktiengesellschaft & Co, Germany). USG was measured within two hours after collection of the samples using digital hand held refractometer PAL-10S (Atago, USA). USG measuring range of this device is 1.0000-1.060, resolution 0,001 and accuracy ± 0.001 units.

Some discrepancy exists in the literature regarding the definitions of euhydration and hypohydration based on USG values. In particular, USG values of 1.010–1.020, which are considered consistent with euhydration according to American College of Sports Medicine [5] and National Collegiate Athletic Association [7] criteria, indicate minimal hypohydration compared with the National Athletic Trainers' Association's (NATA) more detailed classification system [6]. In the current paper, we classify our rugby players with USG ≤1.020 "euhydrated", those with USG 1.021-1.030 "hypohydrated", and those with USG >1.030 "seriously hypohydrated".

Statistics

The SPSS version 20 programs were used for statistical analysis of the data. The mean values and standard deviations were calculated for all characteristics. A dependent *t*-test for paired data groups was employed to determine differences between the characteristics before and after training, and *t*-test for unequal data groups to detect differences between the same characteristics in cool (early spring) and warm (summer) environment. The linear correlation analysis was used to determine relationships between various characteristics. Statistical significance was set at $p<0.05$.

Results

The anthropometric and body composition data of the participants are summarized in Table 1. The mean body mass index exceeded the norm 25 kg/m^2 (Table 1), its value was increased in 18 players from 24, in two players the obesity was observed: their body mass index was greater than 30 kg/m^2 (32.37 and 35.28 kg/m^2, respectively) and body fat 25.7% and 24.5%. The body fat percent above 20 % was determined only in these two athletes. The significant relationship between the age of rugby players and the body fat content in percents was not detected ($p>0.05$). The significant linear relationship was determined between the body fat content and the body mass index ($r = 0.88$, $p<0.001$). This means that the increase of the body mass index was determined by the body fat growth.

Table 1. The mean anthropometric and body mass composition data of well-trained rugby seven players before training

Characteristics of rugby seven players	Mean value ±	Variation range
Age (years)	26.19 ± 4.95	18-33
Height (cm)	186 ± 6	174-197
Body mass (kg)	92.61 ± 13.58	64.05-112.59
Body mass index (kg/m^2)	26.79 ± 3.60	18.92-35.28
Body fat content (%)	13.84 ± 5.40	5.0-25.7
Total body water (%)	63.38 ± 4.00	54.2-69.7

The mean pre-training urine specific gravity in rugby players in cool environment was 1.019 ± 0.008 (Table 2), which was in norm. Euhydration (USG ≤1.020) was observed in seven rugby players from 13 or 54 %, which was more than half of all athletes (Figure1). Hypohydration was observed in five athletes or 38% of players (USG 1.021-1.030). Only one rugby player or 8% was seriously hypohydrated (USG > 1.030).

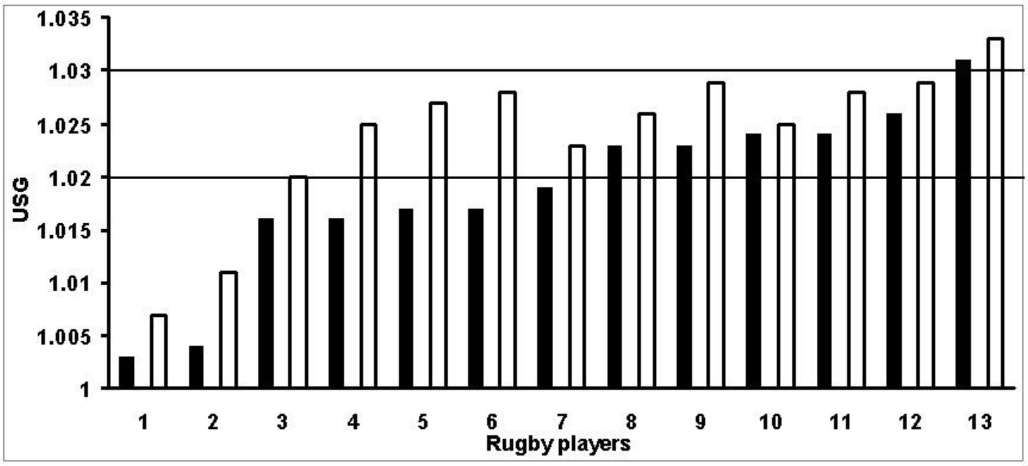

Figure 1. Individual values of pre- (■) and post-training (□) urine specific gravity in rugby seven players in cool environment (spring). Horizontal lines at 1.02 and 1.03 indicate cut-off values for hypohydration and serious hypohydration, respectively

USG varied in wide range in subjects: from 1.004 to 1.031 (Table 2).

The body hydration degree worsened after training. The mean urine specific gravity after training 1.024±0.007 (hypohydration) was significantly greater than USG before training in cool environment (p<0.001) (Table 2). Euhydration (USG ≤1.020) was observed only in three rugby players or 23 % from players (Figure 1). Hypohydration was detected in nine athletes or in 69 % of players or more than two thirds of rugby players (USG 1.021-1.030). Only one player who was seriously hypohydrated before the training remained seriously hypohydrated (USG >1.030) after training too. USG variation among the players was slightly smaller than before it: from 1.007 to 1.033 (Table 2).

The mean pre-training urine specific gravity in rugby seven players in warm environment was 1.021 ± 0.005 (Table 2), which exceeded the boundary of norm. Euhydration (USG ≤ 1.020) was observed in five rugby players from 13 or 38%, which is more than one third part of athletes (Figure 2). Hypohydration was observed in eight athletes or close to two thirds or 62% of players (USG 1.021-1.030). Nobody was seriously hypohydrated (USG > 1.030). USG varied in subjects in the range from 1.011 to 1.027.

The body hydration state none significantly worsened after training (p>0.05). The mean urine specific gravity after training was 1.023±0.006 (hypohydration) (Table 2). Euhydration (USG ≤1.020) was observed only in three rugby players or 23% (Figure 2). Hypohydration was detected in nine athletes (69 %) or more than two thirds of rugby players (USG 1.021-1.030). Only one rugby player (eight percents) was seriously hypohydrated (USG > 1.030). USG variation among the players was smaller: than before the training from 1.017 to 1.036 (Table 2).

Table 2. The mean pre- and post-training body mass and USG in well trained male rugby seven players in cool and warm environment

Characteristics	Pre-training	Post-training	Mean difference	Statistical significance of difference
Body mass (kg) in cool environment	90.75 ± 18.13	89.68 ± 17.82	−1.07 ± 0.84	Not significant, p>0.05
Body mass (kg) in warm environment	94.46 ± 6.92	94.08 ± 6.78	−0.37 ± 0.30	Not significant, p>0.05
Stat.sign.of mean body mass difference in cool and warm environment	Not signif., p>0.05	Not signif., p>0.05	Significant, p<0.01	-
USG in cool environment	1.019 ± 0.008	1.024 ± 0.007	0.005 ± 0.003	Significant, p<0.001
USG in warm environment	1.021 ± 0.005	1.023 ± 0.006	0.002 ± 0.004	Not significant, p>0.05
Statistical significance of USG difference in cool and warm environment	Not signif., p>0.05	Not signif., p>0.05	Not signif., p>0.05	-

The positive linear relationships were determined between the pre- and post-training USG in rugby seven players (Figure 3): This equation in warm environment was:

$$USG_{\text{after training}} = 0.166 + 0.842 \cdot USG_{\text{before training}};$$

where r = 0.92, p<0.001, the standard error of the equation is 0.003.

The relationship in cool environment was:

$$USG_{\text{after training}} = 0.039 + 0.964 \cdot USG_{\text{before training}};$$

where r = 0.81, p<0.001, the standard error of the equation is 0.004. This proved that the athletes' body hydration status more worsened after training if they were hypohydrated before the training.

The mean body mass of the players did not significantly decreased after one and half hour of training in cool, as well as, in warm environment (Table 2). The greatest decrease of the body mass in rugby players was 3.08 kg or three percents from the pre-training body mass which was observed in cool environment. Decrease of body mass (>2%) which could impair performance was observed only in two athletes and only in cool conditions, body mass diminishing between 1.5% and 2% was detected in six players also only in spring (Figure 4). Body mass decrease exceeded 1 % of the pre- training body mass only in two players in warm environment, in other athletes the post- training body mass decrease was <1%. Increase of the body mass for 0.38 kg in cool and for 0.33 kg in warm environment or <0.5% after training was observed only in one player in spring and one – in summer, respectively. The mean body mass decrease after training in kilograms in cool environment was statistically significantly greater in comparison with the mean body mass diminishing in warm environment (p<0.01) (Table 2). The mean body mass decrease after training in percents from pre- training body mass in cool conditions (–1.15 ± 0.83%) was significantly greater in comparison with the body mass decrease after training in warm environment (–0.39 ± 0.31%), p<0.007.

The correlation between the body fat content in percents and the body mass changes due to training was not significant (p>0.05). The correlation between the body total water content and urine specific gravity was not determined in the rugby players (p>0.05).

The mean water consumption during training in warm environment 1.169 ± 0.313 litres was statistically significantly greater in comparison with water uptake in cool environment 0.167± 0.025 litres (p<0.0001itres). Water uptake in summer varied from 0.887 to 1.288 litres, but in early spring variation of water uptake was smaller – from 0.160 to 0.250 litres.

The mean sweat loss by every player during training in cool environment was 1.25 ± 0.805 litres, but in

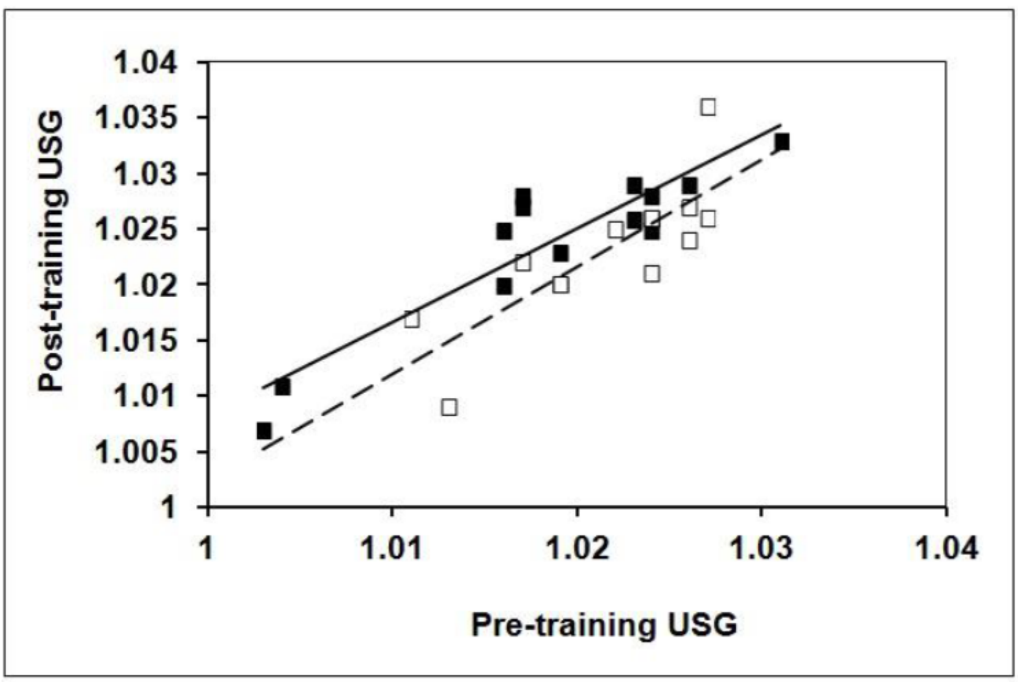

Figure 3. Relationship between pre- and post-training USG in well trained male rugby seven players: in cool environment (–□–); r = 0.92, p<0.001; in warm environment (--■--); r = 0.81, p<0.001

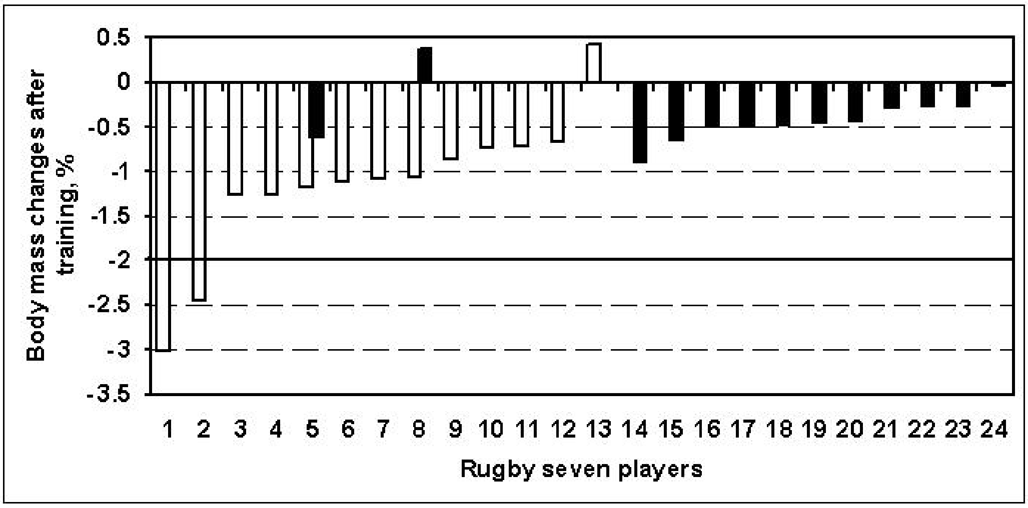

Figure 4. Individual values of body mass changes after training in well trained male rugby players in moderate (□) and warm (■) environment. Horizontal line at –2% indicate cut-off value for decrease in physical performance [19]

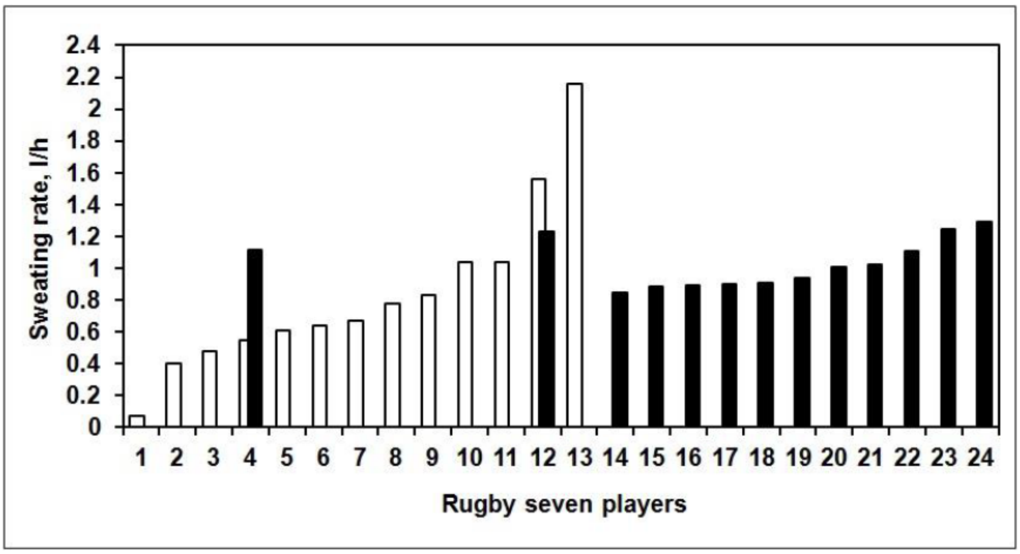

Figure 5. Individual values of sweating rate during training in well trained male rugby players in cool (□) and warm (■) environment

warm conditions 1.513 ± 0.205 litres. The mean sweating rate in cool conditions was 0.883 ± 0.537 litres per hour (l/h), but in warm environment – 1.030 ± 0.152 l/h, the difference between the mean values was not statistically significant ($p>0.05$). The sweating rate in spring varied in wide range from 0.07 l/h to 2.16 l/h, but in summer only from 0.847 l/h to 1.288 l/h (Figure 5).

The relationship between sweating rate and body mass changes during training was very close in cool environment and characterized by the equation (Figure 6):

$$BM_{changes} \text{ (kg)} = 0.225 - 1.560 \cdot \text{Sweating rate (l/h)};$$

where $r = 0.99$, $p<0.001$ and standard error of the regression equation was 0.090 kg. The correlation between sweating rate and body mass changes during training in warm environment was not determined ($p>0.05$). The correlation between water consumption during training and sweating rate of rugby players was not significant in cool and warm environment ($p>0.05$). The correlation between water consumption and body mass changes during training was not significant in cool conditions (in spring) ($p>0.05$), but statistically significant in warm environment (Figure 7):

$$BM_{changes} \text{ (kg)} = 0.691 \cdot \text{water consumption (l)} - 1.184;$$

where $r = 0.72$, $p < 0.005$ and standard error of the regression equation was 0.216 kg.

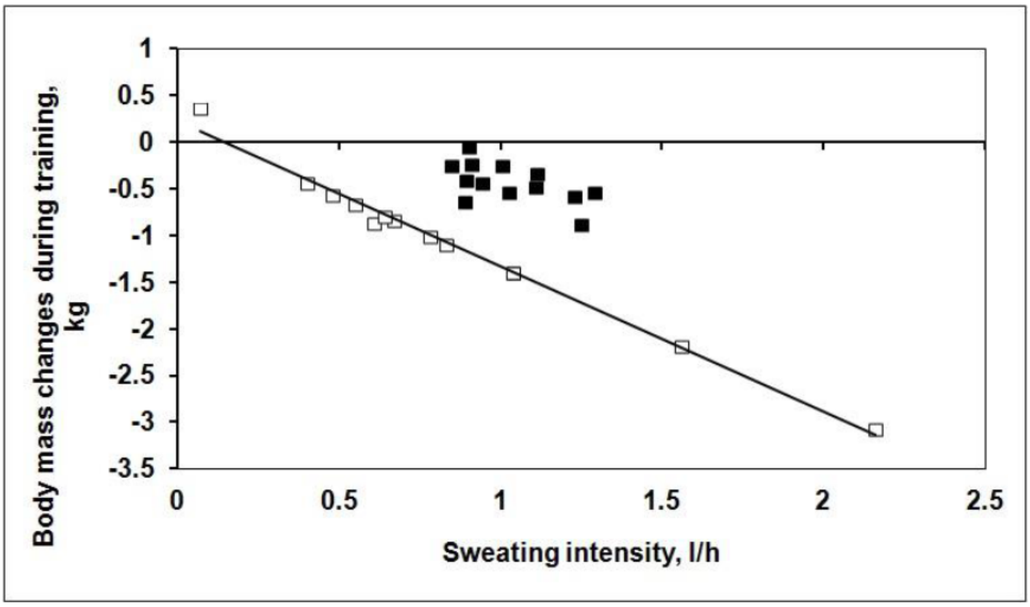

Figure 6. Relationship between sweating rate and body mass changes during training in well trained male rugby seven players in cool environment or early spring (–□–), r = 0.99 and p<0.001. This correlation did not exist in warm environment or summer (■), p>0.05

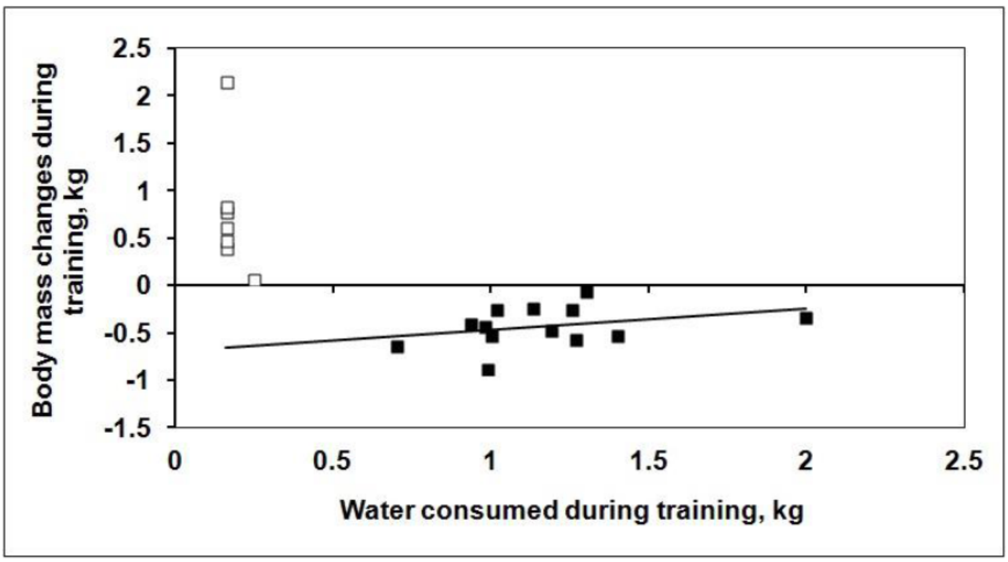

Figure 7. Relationship between water consumption and body mass changes during training in well trained male rugby seven players in warm environment or summer (–■–), r = 0.72 and p < 0.005. The correlation was not significant in cool conditions or spring, p>0.05

The mean BSA of rugby players participated in the investigation in cool conditions was 2.174±0.276 m^2, but BSA of players participated in the training in warm environment 2.202±0.102 m^2, the difference between the mean values was not statistically significant (p>0.05). The relationship between the BSA of athletes and sweating rate was statistically significant in cool environment (Figure 8):

Sweating rate (l/h) = 1.456 · BSA (m^2) – 2.334;

where r = 0.75, p<0.003 and standard error of the regression equation was 0.373 l/h. The correlation between BSA and sweating rate was not significant in warm conditions (p>0.05).

Discussion

Mean pre- practice urine specific gravity of Latvian national rugby seven team players in cool environment was 1.019±0.008 (norm), but in warm

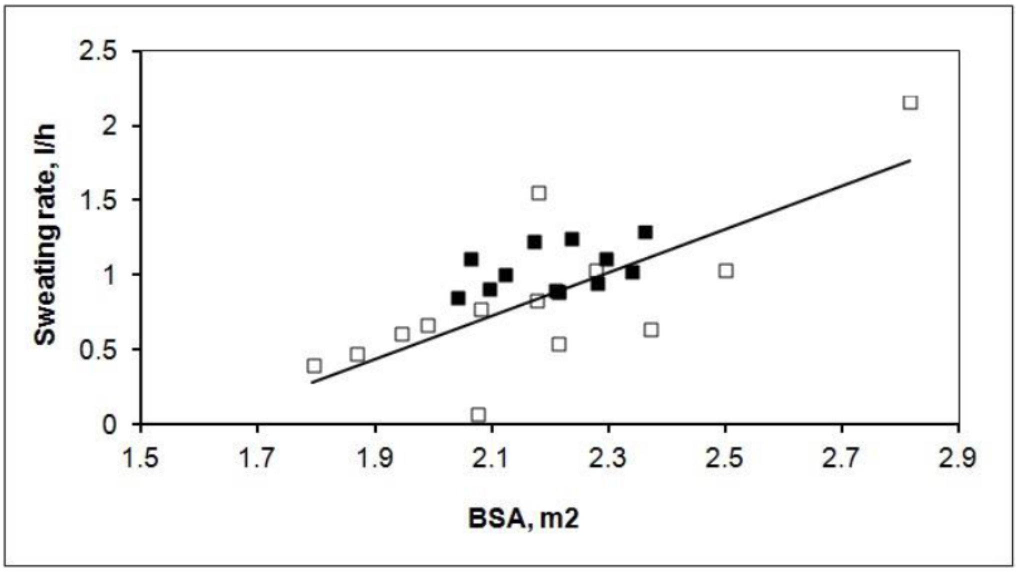

Figure 8. The relationship between the BSA of athletes and sweating rate in moderate environment (–□–), r = 0.75, p<0.003 and standard error of the regression equation was 0.373 l/h. The correlation between BSA and sweating rate was not significant in warm – environment (■), p>0.05

environment 1.021±0.005 (hypohydration), the difference was not statistically significant (p>0.05). In both: cool and warm environment the mean hydration of rugby players is close to the lowest boundary of hypohydration – USG 1.020. Controversially, in the studies of Lee et al. [11] the mean pre-training urine osmolality was 423±157 mOsmol/kg and in the investigations of Jones et al. [12] –423±157 mOsm/kg. In both cases urine osmolality indicates adequate levels of athlete's body hydration.

From our data half or more from all rugby players were hypohydrated before training from the results of USG: 46% of rugby players were hypohydrated in cool environment and 62% of rugby players – in warm environment. These results are in a good agreement with the data about high prevalence (47–60%) of pre-training hypohydration in semiprofessional soccer players [13] and in approximately half of basketball players before the play match from the data of USG [14]. Stover et al. [15] reported similar mean pre-training USG values in two big groups of recreational exercisers living in Chicago and Los Angeles, where the ambient temperature during the study averaged –5°**C** and 20.6 °C, respectively. In the pooled sample from the two cities the prevalence of pre- training hypohydration was 49%.

Insufficient fluid intake for athletes training in cold and moderate temperatures can be explained by reduced thirst sensation [16]. For example, the fluid intake volume among elite football players in a cold environment (5°C) was much smaller than the sweat loses [17]. Despite their accurate intake of fluid, runners also underestimate their sweating intensity in cool weather conditions [18]. These data are in good agreement with our results obtained in rugby seven players: fluid consumption according to the thirst sensation in cool conditions was insufficient in preventing the body hydration status worsening and a decrease in BM for more than 1.5-2% in some players, which can negatively influence the performance [19]. From our data the fluid consumption based of the thirst sensation in warm environment better allows prevent the body hypohydration and keep the BM decrease below 1.5 %.

Perrella et al. [20] detected that body hypohydration and the mean post-training BM loss of 1.5±0.7% was enough to provoke the thirst sensation. So large mean BM loss during training was not found in the rugby players tested in our study in summer and in greatest number of athletes in early spring. Therefore there was no additional stimulation to the thirst sensation in these players, which does not provoke fluid consumption during the training.

O'Hara et al. [21] determined that the mean BM loss during the rugby game was 1.28 ± 0.7 kg or 1.3% from the pre-training body mass (the mean air temperature 12.1±5.3°C, the relative humidity 70.5±11.4%). These data are in good agreement with our results obtained in early spring in similar environment (the mean air temperature +10°C, the relative humidity 65%): the mean BM loss –1.07±0.84 kg or 1.15% from the pre-training body mass. The BM decrease of our rugby players after training in warm environment

0.37±0.30 kg or 0.39% was significantly lower than in cool environment ($p<0.001$)). This suggests better sweat loss compensation by fluid consumption before training and during it in warm environment in comparison with cool conditions.

From the data of O'Hara et al. [21] the mean volume of consumed fluid by every rugby player during training 1.64±0.5 liters was greater in comparison with our data of the mean fluid consumption of 0.167±0.025 liters during training in cool conditions (air temperature +10°C, the relative humidity of 65%) and 1.170±0.300 liters in warm environment (air temperature +27°C, the relative humidity of 35%).

O'Hara et al. [21] observed the mean loss of sweat of every player during the training 2.0±0.7 liters, and it was greater than observed in our study 1.25±0.805 liters in cool and 1.513±0.205 liters in warm environment. This could be explained by suggested smaller load intensity and insufficient fluid consumption during trainings in our players. O'Hara et al.[21] estimated the body hydration state of rugby players from the data of urine osmolality as athletes arrived to the stadium, before the game, in the game halftime break and after the game: 396±252 mOsmol/kg, 237±177 mOsmol/kg, 315±133 mOsmol/kg and 489±150 mOsmol/kg, respectively. All these data correspond to norm.

Contrary to this we determined hypohydration of our rugby players from the mean pre-practice USG of 1.021±0.005 in summer and the highest boundary of norm 1.019±0.008 in early spring, but post-practice USG in summer (1.023±0.006) and spring (1.024±0.007) showed hypohydration in both environments. This proves insufficient fluid consumption in our rugby players in comparison with the athletes from the study of O'Hara et al. [21].

Hydration status in athletes is a factor influencing efficiency of the training. The body hypohydration observed in many rugby players especially worsen the cardiovascular system functions and aerobic performance of athletes. For example, Aldridge et al. [22] tested the influence of hypohydration on the aerobic workload capacity of rugby players in moderate environment (20°C). They found statistically significant heart rate differences between euhydrated and hypohydrated rugby players (78.4±12 and 84.9±9.4 beats per minute, respectively). These differences increased after cycle ergometry testing with duration of 30 minutes: the mean heart rate was 115.6±12.4 beats per minute in euhydrated and 123.8±12.9 beats per minute in hypohydrated rugby players ($p<0.01$).

Conclusions

1. Mean pre- practice urine specific gravity of Latvian national rugby seven team players in cool environment was 1.019±0.008 (norm), but in warm environment 1.021±0.005 (hypohydration), the difference was not statistically significant ($p>0.05$). More than half of rugby players were hypohydrated before the training: 46% in cool conditions and 62% in warm environment.

2. After 1.5 hours of training in both: cool and warm environment the hydration state of players worsened: nine from 13 rugby seven players or 69% were hypohydrated and only one player was seriously hypohydrated. The positive linear relationships were determined between the pre- and post-training USG in rugby seven players both: in cool ($r = 0.92$; $p<0,001$) and warm environment ($r = 0.81$; $p<0,004$).

3. Decrease of body mass (>2%) which could impair performance was observed only in two athletes and only in cool conditions, body mass diminishing between 1.5% and 2% was detected in six players also only in early spring. Body mass decrease exceeded 1 % of the pre- training body mass only in two players in warm environment, in other athletes the post-training body mass decrease was <1%.

4. The relationship between sweating rate and body mass changes during training was very close in cool environment ($r = 0.99$; $p<0.001$), but in warm environment the correlation between sweating rate and body mass changes during training was not determined ($p>0.05$). This can be explained by better body rehydration based on the thirst sensation during training in summer.

5. The correlation between water consumption and body mass changes during training was not significant in cool conditions ($p>0.05$), but positive statistically significant in warm environment ($r = 0.72$; $p<0.005$). Therefore increase of fluid consumption during training in summer cause diminishes the body mass decrease.

Highlights

The results indicate that in well-trained rugby seven players pre-training hydration status evaluated on the basis of USG does not differ in cool temperature early spring and warm summer. The mean USG coincides with the highest boundary of norm or lower border of hypohydration. High prevalence (46-62%) of pre-training hypohydration confirms that daily fluid uptake is not enough and the players need evidence-based recommendations and qualified guidance for adequate fluid replacement. The results also suggest that individual-related factors such as pattern of voluntary fluid intake may have stronger impact on hydration status than environment-related factors like natural alternation of seasons.

The positive linear relationships between the pre- and post-training USG in rugby seven players both: in cool and warm environment proves, that starting the training in hypohydrated state, a player's hydration during the training and at the end of it most likely will become worse and fluid uptake during the training will not compensate fluid loss and the worsening of the body hydration status.

Decrease of body mass (>2%) which could impair performance was observed only in some athletes and only in cool conditions. The relationship between sweating rate and body mass changes during training was very close only in cool environment. This can be explained by lowered thirst sensation and therefore decreased the fluid consumption and body rehydration during training in cool environment in comparison with warm.

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