HONG KONG SPORTS INSTITUTE
香港體育學院

RESEARCH HIGHLIGHTS

Fluid Intake, Fluid Loss and Sweat Composition in Elite Fencers during Training

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Introduction

Exercise performance is optimal when athletes maintain fluid balance during exercise. Numerous studies have shown that dehydration of 2% body weight increases cardiovascular strain [1], decreases exercise performance [2], and hinders the thermoregulation and heat acclimatization [3]. Fencing is a combat sport which requires fencers to wear protective fencing clothing, a mask, gloves and plastron. This protective equipment may hinder heat dissipation during exercise and may increase the rate of fluid loss.

Replacing fluid and electrolytes may play an important role in preventing fluid and electrolyte imbalance [4] and heat-related illness in sports [5]; therefore, knowing an athlete's sweat rate and sweat composition could assist sports scientists in planning individualized electrolytes and fluid replacement strategies. However, there is a paucity of studies on sweat rate, sweat electrolyte composition and fluid balance of fencers in the world. The aim of this study was to investigate fluid and electrolyte losses in a group of elite fencers during a single training session. A measurement of pre-training hydration status was also observed.

Methodology

A total of 14 male fencers (four sabres, six epees and four foils) participated in this study. Upon arrival at the training venue, fencers were asked to provide a urine sample which was subsequently analyzed for urine specific gravity (USG) (Pen Refractometer, Atago, Japan) to determine pre-training hydration status. After the bladder was emptied, fencers were weighed to the nearest 0.1g in dry in lightweight clothing as pre-training body weight (Tanita UM007, Japan). Afterwards, absorbent patches (Tegaderm +Pad; 3M, 5cm x 7cm) were applied to three skin sites (chest, subscapular and lower back) for sweat collection. The skin was thoroughly cleaned with alcohol and dried before the patches were applied. Drink bottles were weighed using electronic scale (Shimadzu TXB6201L, Japan) before and after training to determine the amount of water consumed. Before the training session started, ambient temperature, humidity and starting time were recorded. After warm up, each fencer fenced five to six bouts during the training session which was similar to competition. Fencers could drink water ab libitum during the training session. If fencers needed to urinate during the training session, body weight was measured before and after urination. At the end of training session, each fencer needed to towel dry, reweigh in light clothing, then empty their bladder and reweighed again to determine urinary loss and post training weight. Moreover, sweat patches were removed with sterile tweezers and immediately placed inside the barrel of a 10-ml syringe. A sweat sample was removed by squeezing the syringe plunger. The concentrations of sodium and potassium were measured by ion chromatography (Metrohm, Switzerland).

Statistical Analysis

Data were presented as mean ± SD. Correlation analysis was performed by Pearson correlation. Hourly fluid intake, hourly sweat loss, USG, sweat composition among three different weapons were determined by one-way ANOVA and Bonferroni test. The significance level was set at 0.05.

Results

Mean pre-training USG, fluid intake, sweat loss rate, sweat composition and percent dehydration of different weapons summarized in Table 1. According to American Journal of Sports Medicine, USG value greater than 1.020 results in dehydration [6]. Both sabre and foil teams were dehydrated before training and a significant difference was found between epee and foil ($p < 0.05$). Sabre team had a higher mean fluid intake than foil and epee teams. There was no significant relationship between the hourly fluid intake and hourly sweat rate (Figure 1). Neither the sweat rate nor the sweat sodium concentration during training was correlated with the pre-training hydration status as assessed by USG (Figure 2-3). Among three weapons, foil team was found to have a higher the sweat sodium and potassium concentration than sabre and epee. Sabre team had higher hourly sweat loss than epee and foil (Table 1). Although all three weapons percent of dehydration were within the recommendation (< 2%) [6], sabre team had a better fluid replacement strategy than epee and foil (Table 1). There was no significant relationship between total sweat loss and sweat sodium concentration and percent of dehydration and sweat sodium concentration (Figure 4-5).

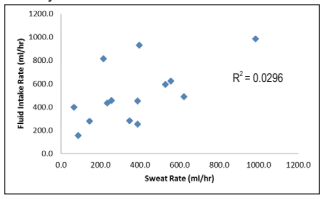


Figure 1. Relationship between the hourly sweat rate during training and the hourly fluid consumed (n = 14)

Table 1. Pre-training USG, sweat electrolytes content, sweat rate and fluid balance among 3 weapons (n = 14)

	Sabre (n = 4)	Epee (n = 6)	Foil (n = 4)
Pre-training USG*	1.024 ± 0.09	1.014 ± 0.06	1.027 ± 0.02
Sodium (mmol/L)	45.5 ± 13.3	59.6 ± 16.0	63.5 ± 9.6
Pre-training weight (kg)	72.3 ± 3.9	72.8 ± 9.2	72.1 ± 10.1
Hourly fluid intake (ml/hr)	484.0 ± 112.6	355.8 ± 128.2	432.6 ± 413.8
Hourly fluid loss (ml/hr)	617.2 ± 217.1	649.1 ± 240.0	641.2 ± 318.5
Hourly sweat loss (ml/hr)	617.2 ± 217.1	409.1 ± 149.2	557.9 ± 404.1
Fluid replaced (%)	86.0 ± 34.5	57.1 ± 17.9	49.1 ± 36.9
Dehydration (%)	0.23 ± 0.55	0.58 ± 0.31	0.63 ± 0.59

* Significant difference was found between Epee and Foil

Figure 2. Relationship between pre-training USG and the sweat rate during training (n = 14)

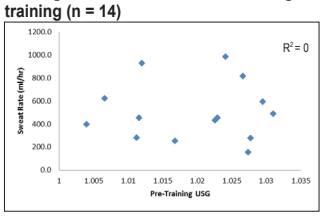


Figure 3. Relationship between pre-training USG and the sweat sodium concentration (n = 14)

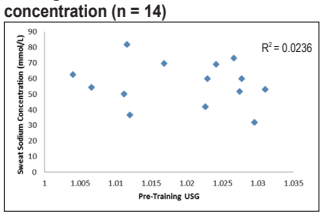


Figure 4. Relationship between total sweat loss during training and sweat sodium concentration (n = 14)

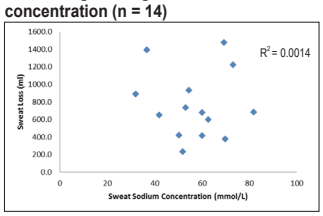
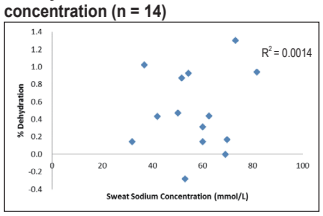


Figure 5. Relationship between % dehydration and sweat sodium concentration (n = 14)



Discussion

Fencers in the present study consumed sufficient fluid during training to match sweat losses and the percent of dehydration was within the recommendation (< 2% of dehydration) [6] (Table 1). Numerous studies showed that a small percent of dehydration is unlikely to have detrimental effect on exercise performance [7]. Cognitive performance, which is an important aspect of fencing, may also be impaired by dehydration. Gopinathan et al [8] showed that performance in a variety of tests of cognitive function was adversely affected when the dehydration was greater than 2% of the initial body weight. Although all fencers were less than 2% dehydration, further investigation between the percent of dehydration and cognitive performance in fencing is worthwhile.

Apart from regular drinking during exercise, well-hydration status before exercise is necessary to prevent dehydration. The measurement of USG prior to exercise is commonly used by sports scientists to assess athlete's hydration status. Mean pre-training USG indicated that sabre and foil teams were found higher than recommendation (< 1.020 means good hydration) that indicated these fencers were dehydrated prior to the start of the training (Table 1). It is necessary to reinforce fencers to have good hydration practice before exercise. Similar to another study, no association among pre-training hydration status, sweat sodium concentration and sweat rate was found [9].

Sweat electrolyte concentration was reported within the physiological range of about 20 – 80mmol/L for sodium [10]. The Foil team had a higher mean sodium concentration than sabre and epee but no significant difference was found (Table 1). Epee and foil teams had a higher mean sweat sodium concentration than soccer players [7,11]. Similar to another study [7], there was no apparent association between sweat sodium concentration and total sweat loss, sweat sodium and percent of dehydration.

Conclusion

Although foil and sabre teams were dehydrated prior to the exercise, they drank adequately amount of fluid during training so that the % dehydration during exercise is less than 2%. Moreover, the inter-individual variation of sweat composition and sweat rate between fencers in the same team taking part in the same training session was so great that individualized fluid replacement programs are necessary.

Reference

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