05 - EVALUATION OF HYDRATION BALANCE AND URINE PARAMETERS IN MALE SWIMMERS

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INTRODUCTION

According to WILMORE and COSTILL (2001) and WEINECK (2000), the athlete generally enters a training session or competition with an unconscious deficiency of water, thereby hurting their performance by reaching the negative limit of water balance. The relationship between the liquid swimming medium and the ingestion of water is cited by CLARK (1998), saying that swimmers believed that by being immersed in a liquid they did not sweat and did not need to drink water. This negligence in the intake of water can actually become habitual and hinders reaching full performance potential. In other words, it can be concluded that even though they are surrounded by water, swimmers are vulnerable to suffer from dehydration.

DUARTE e CASTELLANI (2002) define dehydration as being “a syndrome of multiple causes that can be caused by insufficient ingestion of water, excessive loss, or both.” Activities of medium and high intensity, especially when associated with stressful ambient temperatures, can be associated with water loss through perspiration and if not corrected, can lead to dehydration (ARMSTRONG, 2000). Even a slight dehydration during exercise can cause a cardiovascular overload and a disproportionate elevation in cardiac frequency (GHORAYEB, 1999). According to MCARDLE, et al. (1998), an individual, who practices prolonged and intense exercise, can loose up to three liters of water per hour through perspiration. As a result, if there is not a balance between the quantity of liquid ingested and the quantity of liquid lost, perspiration stops being a positive mechanism for the dissipation of heat. This can result in negative consequences such as muscle spasms, significantly increased body temperature, nausea, exhaustion, heat stroke, decreased resistance, fatigue and even serious risk of death (SAWKA, 1992; ACSM, 1996; HIRSCHBRUCH and CARVALHO, 2002).

To avoid the adverse effects of dehydration on athletic performance, the ingestion of water in sufficient quantities to compensate perspiration has been recommended by international consensus (ACSM, 1996; CASA, et al, 2000; VIMIEIRO and RODRIGUES, 2001).

PORTO (2001) classifies dehydration in 4 levels: ***weak*** (up to 5% of body weight), **moderate** (6 to 8 % of body weight), ***intense*** (8 too 10% of body weight) and ***severe*** (more than 10% of body weight). The balance of water of the organism is defined by the quantity of water that is imbibed compared to the amount of water that is excreted. When the ideal condition is adversely affected by physical activity, the organism activates mechanisms to maintain homeostasis through regulating the secretion of ADH (vasopressin) that promotes the conservation of water, and through the regulation of thirst and ingestion (RIELLA, 2000).

WEINECK (2000) says that: “due to limited absorption capacity of the large intestine, the quantity of liquid imbibed should not exceed 200ml per 15 minutes”. The author affirms that water without electrolytes is quickly eliminated through the kidneys, due to the fact that it cannot be retained by the organism, leading to a further loss of electrolytes, subsequent additional loss of water and deteriorating performance.

As to the importance of adequate hydration during exercise, WILMORE and COSTILL (2001) believe that for an ideal performance, the amount of water in the body and the content of electrolytes should be maintained relatively constant, which does not always happen. A well hydrated athlete always works at a higher physiological and performance level than a dehydrated athlete. An adequate condition of hydration is only maintained in physically active people if they drink sufficient liquids before, during or after physical activity. When an individual who exercises does not recharge voluntarily all of his lost liquid, he is in what is called voluntary dehydration. Some studies done with different liquids show that those with a slight taste are generally more accepted for the voluntary replenishment of liquids. The addition of carbohydrates and or electrolytes in water can increase the ingestion of liquids and retard fatigue in endurance of more than 60 minutes (HIRSCHBRUCH and CARVALHO,2002).

To move muscles, water is needed. The metabolically active tissues such as the muscles present the highest water concentration. The electric stimulation of nerves in contracting muscles occurs due to the exchange of mineral electrolytes dissolved in water (sodium, potassium, chlorides, calcium, and magnesium) through muscle cell membranes. As a result, if water and the electrolytes were in low concentration, strength and muscular control weaken (KLEINER, 2002). MCARDLE, et al. (2001) state that “in a practical sense the quick loss of weight through dehydration probably does not affect performance potential in exercises of short duration (up to 60 seconds)”. However, “when the exercise lasts more than 1 minute the dehydration profoundly affects physiological functions and the capacity of the individual to optimally train and compete”.

Regarding the warning signs of dehydration, KLEINER (2002) talks about precocious and severe signs. The precocious signs are fatigue, a loss of appetite, reddish skin, heat intolerance, dizziness dark urine with a strong odor and a dry cough. The severe signs are trouble swallowing, slow reflexes, loss of coordination, wrinkled and deep-set eyes, blurred vision, pain to urinate, skin without sensitivity, muscular spasms and *delirium*.

The best way for the swimmer to measure the state of dehydration according to COSTILL, et al. (1998), is to control his weight every morning and observe the coloration of urine. Sudden losses of body weight are normally attributed to a reduction in water retention. Because the kidneys are responsible for regulating the quantity of water in the body, a dark yellowish urine indicates that the kidneys tried to conserve water, while a diluted and clear urine suggests that there is a good state of hydration.

The specific gravity of urine or urine density has been considered as a satisfactory non-invasive method for the evaluation of hydration level of athletes (ARMSTRONG et al 1998). The urine density measures the relative mass of the solvents and solutions in a sample of urine in relation to pure water and can be verified on a portable, simple and precise instrument, the refractometer with a scale from 1000 to 1040. Any fluid that is more dense than water has a specific gravity greater than 1000. In dehydration and in hypohydration, the values of specific gravity of urine can pass 1030. When the individuals are euhydrated, they can vary between 1013 and 1029 and in hyperhydration can vary between 1001 and 1012 (ARMSTRONG, 2002; VIMEIRO and RODRIGUES, 2001).

Knowing that there is little information in literature that discusses the problems of dehydration in swimming, the present study had the objective of seeking more precise comparisons through the specific gravity variations and coloration of urine and about the relation between the dehydration and the drop in performance of athletes that practice this sport.

METHODS

This study was approved by the UNICENP university in Curitiba (April of 2003). The volunteer athletes were given to sign a term of consent and all the information necessary on all the procedures to be followed during the urine sampling. The population sample consisted of 5 athletes swimming at international level (minimum of 10 years of experience) and training daily in a 50 meter pool in the city of Curitiba.

The male athletes of Brazilian descent, ages between 18 and 22, participated of the study during one month, from March 14th to April 9th, 2003. Three weekly samples were taken, totaling 12 for each athlete. During the training sessions, ambient and pool temperature were monitored, as well as, the volume of the water taken and the distance swum. Before and after the training, their weight was verified and the specific gravity and coloration of their urine. On each day of sampling the volunteer had his beaker and urine identified and his weight verified on a mechanical scale before and after the training. For this moment the athlete was "dry", bare foot and only with swimming trunks.

One drop of urine (20 ul) was deposited on a refractometer, indicating the level of dehydration of the individual on the visor. The evaluation of the coloration of the urine was done utilizing a scale of 8 points proposed by ARMSTRONG et al (1994) and eventually published in color (ARMSTRONG, 2000). The median value of perspiration was calculated considering the body mass of the athletes before ($P_{initial}$) at the end of the training (P_{final}), the quantity of water (H_2O) imbibed (ad libitum) by the end of the pool workout, calculated in with accordance with the equation:

Amount of perspiration $= (P_{initial} + H_2O) - P_{final}$

The tabulated data was analyzed statistically ($p<0.05$) using Means ± Standard Diversion (SD) of student t-test for the presentation of the results, discussion and conclusions of this study.

RESULTS

Table 1 presents the age (20 ± 1,82 years) and the anthropometric measurements of the evaluated atheletes. Knowing the value of body weight and height, it was possible to find the estimated superficial area of the body (2,04m^2) (MCARDLE, KATCH e KATCH, 1998).

TABLE 1: Swimmer Characteristics

	Age(years)	*Body Weight (kg)*	*Height (cm)*	*A.S.C (m^2)*
Mean	20	80.22	188	2.04
SD	1.82	0.62	5.55	0.08

Table 2 shows that the value of water imbibed (553.14 ± 109.52ml.h^{-1}) and the value of perspiration (281.84 ± 85.27ml.m^{-2}.h^{-1}) with a variation in weight of 0.06 Kg, the equivalent of 0.07%, from the mean weight of athletes. This variation of weight is negative because the replacement of water loss was 91.73%.

TABLE 2: Variation of body weight and state of hydration after training session.

	Intake value *(ml.h^{-1})*	**Perspiration value** *(ml.m^{-2}.h^{-1})*	**Variation of wt-dehydration** *(kg)*	**Variation of wt - dehydration** *(%)*	**Replacement of water loss** *(%)*
Mn	553.14	281.84	0.06	0.07	91.73
SD	109.52	85.27	0.38	0.47	51.62

The total intake of water during a session of training was from 1521.13 ± 301.18 ml and the perspiration total was from 1581.13 ± 478.43ml. Figure 1 presents the difference between the intake of water (ad libitum) and the total perspiration.

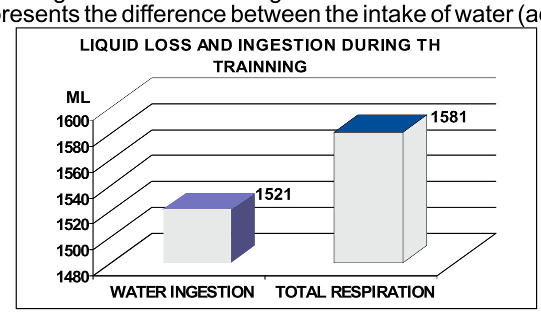

FIGURE 1: Median Values of total perspiration of water ad libitum during the training sessions (165±12 minutes) of a international level swimming team

Table 3 shows that the density of urine at pre-training had a variation of 19.15% on the ARMSTRONG scale(1994), going from 1000 to 1040. The coloration of urine went from 3,90±0.42 in pre-training to 2.58±0,85 after. The variation of body weight was from 0.06 kg at the end of the session of training, or 0.07% less than the median in the beginning.

TABLE 3: Body weight and urine indices.

Period	*Density of Urine*	*Coloration of Urine*	*Body weight(kg)*
pre-training	1.018.04±2,13	3.90±0,42	80.22±0,62
after - training	1.010.38±3,23	2.58±0,85	80.16±0,75

Mean values and SD of specific gravity of urine, coloration and body weight before and after the training.

The mean temperature of the pool pointed to 28,8ºC. In accordance with MCARDLE, et al. (1998) the temperature of water between 26 and 30ºC permits a effective separation of heat during the exercise; however, not necessarily cold enough to compromise the capacity to do the exercises. Table 4 also shows the mean quantity of water taken and the distance swum by each athlete during the training from March 14th to April 9th.

TABLE 4: Temperature, Distance, Water and Distance

	Room Temp *(ºC)*	***Temp of water****(ºC)*	*Imbibed water (ml)*	*Distance(meters)*
Mean	20,28	28,83	1.521,13	6.029,17
SD	1,84	1,45	301,18	1.409,30

DISCUSSION

Through the collected data, it was observed that even before starting the training the athletes were dehydrated. . We believe that this has occurred due to the fact that the athletes drank water only when they were actually thirsty, a sensation that already shows a level of dehydration.

SAWKA (1992) says that when an athlete competes in a state of dehydration, he competes at a disadvantage. We need to remember that it is not only in competition that the athlete can have a disadvantage, but results also depend on technical preparation and perfection that develops during practice

SAFRAN, MCKEAG e CAMP (2002) say that: "Human beings will not maintain a state of eu-hydration during periods of physiological/thermal tension, even when liquid is consumed ad libitum...". Experiments show that athletes replace voluntarily only two thirds of bodily water lost during exercise. Thirst is not a good indicator to show the necessity for liquids during exercise because athletes are already dehydrated 1% upon feeling thirst.

Other factors that could have influenced the results are food in the body and the use of medicines that were not controlled during the study. PORTO (2001) affirms that "you can estimate the level of hydration, rationalizing it with the possible loss of weight between before and after the exercise". However, the information verified does not present a significant enough difference to make such an evaluation.

It was verified that simply drinking "ad libitum" was sufficient to rehydrated the athletes. This could have been facilitated due to the maltodextrin present in the imbibed water, which beyond hydrating also provides energy and a better taste. According to ACSM (1996), to obtain a good hydration during prolonged exercises the addition of carbohydrates (glucose, sacarose, or maltodextrin) can be effective for exercise and a prolonged state of fatigue. Solutions containing 4% to 8% in 600 to 1.200 ml are considered ideal.

In accordance with an experiment of ARMSTRONG (1994), the coloration and density of urine are directly connected. As such, the chart of urine coloration as well as the refractometer are 2 techniques to evaluate dehydration. In this study the 2 techniques presented no significant difference in results.

CONCLUSION

The information in the present study permits us to conclude that the athletes began their training dehydrated (approximetly 2%), that the swimming training in a pool did not change their condition and that the drinking of liquid ad libitum was sufficient to minimize the dehydration verified before the training.

The levels of dehydration measured through the refractometer and from the chart of urine coloration showed high correlation and reliability, but the body weight measurement did not confirm to be a precise indicator for the verification of dehydration.

It is necessary to do more studies to analyze if the specific gravity and coloration of urine are adequate indicators of dehydration in swimmers, so that information about a hydration before and after a training be passed on to the participants of physical activities to improve their performance.

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EVALUATION OF HYDRATION BALANCE AND URINE PARAMETERS IN MALE SWIMMERS

Abstract

Water losses during exercise are dependent on the intensity and the load of thermal stress. Water intake during physical activity has been recommended to replace the loss through perspiration and guarantee the homeostasis of the body. The performance of the athlete swimmer in the pool depends on various factors including genetics, training, motivation and diet. On the diet side there is an important factor that has received little attention from the swimmers and the trainers themselves: the quantity of water intake before, during and after training. The objective of this study was to measure the intake of liquids, the amount of perspiration, the level of dehydration and the coloration and specific gravity of urine during intensive swimming training sessions. Five male athletes with ages 20±1.8, height 188±5.55 cm and body mass 80.22±0.62 kg participated in this study during 30 days of the training. The total time to complete the training sessions was 165±12 minutes, the average temperature of the pool water was 28.83±1.45ºC and the ambient temperature 20.28±1.84ºC. The total amount of perspiration was 1.58±0.48L and the total intake of liquids was 553.14±109.52ml.h^{-1}. The coloration of urine before training was 3.90±0.42 and after training was 2.58±0.85 with the specific gravity at 1.018,04±2.13 and 1.010,38±3.23, respectively. The variation in body masses was 0.07% after a hydric reposition of 8.27±51.62% above total water loss. In conclusion, it was established that swimming workouts in a pool did not mitigate a state of dehydration and the intake of liquids "ad líbitum" was sufficient to minimize the state of dehydration that was verified before the training began.

Key words: swimming, specific gravity, coloration of urine

ÉQUILIBRE ET ÉVALUATION HYDRIC DE COLORATION d'URINE DANS LES NAGEURS MASCULINS

Résumé

Pendant l'exercice, les pertes d'eau sont dépendantes à l'intensité et à la contrainte thermique. Le remplacement hyrdric pendant les activites physiques a été recommandé pour replacer toute la perte de transpiration et pour garantir la homéostasis du corps. L'exécution de l'athlète dépend de divers facteurs comprenant la génétique, l'entraînement, la motivation et la suite d'un régime. Le facteur de régime inclut une chose très importante qu'a été peu observée par les athlètes et même les entraîneurs : la quantité de l'eau ingérée avant, pendant et après l'entraînement. L'objectif de cette étude était de mesurer l'ingestion des liquides, la quantitée de transpiration, la déshydratation, la coloration et la densité de l'urine dans la natation. Cinq athlètes, les âges 20±1,8, la taille 188±5,55cm, le corps 80,22±0,62kg de masse, ont participé à cette étude pendant un périod d'entraînement de 30 jours. La durée de chaque entraînement était de 165±12minutes, la température moyenne de l'eau de piscine était de 28,83±1,45ºC et la température ambiante était de 20,28±1,84ºC. Le montant total de transpiration était de 1,58±0,48L, et l'ingestion totale de maltodrextrina de liquides était de 553,14±109,52ml.h^{-1}, la coloration de l'urine, était de 3,90±0,42 avant la formation et de 2,58±0,85 après, et sa densité était de 1.018,04±2,13 et 1.010,38±3,23, respectivement. La variation des masses corporelles était de 0.07%, après un remplacement hydric de 8,27±51,62% au-dessus des pertes hydrics totales. La conclusion c'est que l'entraînement de natation n'a pas aidé l'état de déshydratation et que l'ingestion de liquides "ad libitum" était suffisante pour réduire au minimum l'état de déshydratation qui a été vérifié avant que l'entraînement ait commencé.

Mots-clés : natation, densité, coloration d'urine

BALANCE HÍDRICO Y EVALUACIÓN DE LA COLORACIÓN DE LA ORINA EN ATLETAS DEL SEXO MASCULINO DE NATACIÓN

Resumen

Durante el ejercicio, las pérdidas hídricas son dependientes de la intensidad y del estrés térmico. La reposición hídrica durante la actividad física ha sido recomendada para reponer la pérdida total por la sudoración y garantizar así la homeostasis corporal. El desempeño del atleta en la piscina depende de varios factores, incluyendo genética, entrenamiento y dieta. Dentro del factor dieta existe algo muy importante que poco ha sido observado por los atletas y los propios técnicos: la cantidad de agua ingerida antes, durante y después del entrenamiento. El objetivo de este estudio fue medir la ingestión de líquidos, la tasa de sudor, la deshidratación, la coloración y gravedad específica de la orina. Cinco atletas del sexo masculino, edad 20±1,8 años, estatura 188±5,55cm, masa corporal 80,22±0,62kg, participaron de este estudio durante el entrenamiento de 30 días. El tiempo total para completar la sesión de entrenamiento fue de 165±12 minutos, la temperatura del agua de la piscina fue de 28,83±1,45º C y del ambiente 20,28±1,84º C. La sudoración total fue de 1,58±0,48L, la ingestión total de líquidos fue de 553,14±109,52ml.h^{-1}, la coloración de la orina fue de 3,90±0,42 antes del entrenamiento y 2,58±0,85 después y la gravedad específica 1.018,04±2,13 y 1.010,38±3,23, respectivamente. La variación de la masa corporal fue de 0,07%, después de una reposición hídrica de 8,27±51,62% arriba de las pérdidas hídricas totales. Se concluyó que el entrenamiento de natación no potencializó el estado de deshidratación y que la ingestión de líquido "*ad líbitum*" fue suficiente para minimizar el estado de deshidratación verificado antes del entrenamiento.

Palabras clave: natación, gravedad específica, coloración de la orina.

BALANÇO HÍDRICO E AVALIAÇÃO DA COLORAÇÃO DA URINA EM ATLETAS DO SEXO MASCULINO DE NATAÇÃO

Resumo

Durante o exercício, as perdas hídricas são dependentes da intensidade e do estresse térmico. A reposição hídrica durante a atividade física tem sido recomendada para repor a perda total pela sudorese e garantir assim a homeostasia corporal. O desempenho do atleta na piscina depende de vários fatores, incluindo genética, treinamento, motivação e dieta. Dentro do fator dieta há algo muito importante que pouco tem sido observado pelos atletas e os próprios técnicos: a quantidade de água ingerida antes, durante e após o treino. O objetivo deste estudo foi medir a ingestão de líquidos, a taxa de sudorese, a desidratação, a coloração e gravidade específica da urina na natação. Cinco atletas de nível internacional do sexo masculino, idade 20±1,8anos, estatura 188±5,55cm, massa corporal 80,22±0,62kg, participaram deste estudo durante o treinamento de 30 dias. O tempo total para completar a sessão de treinamento foi de 165±12minutos, a temperatura média da água da piscina foi de 28,83±1,45ºC e do ambiente 20,28±1,84ºC (termoneutro). A sudorese total foi de 1,58±0,48L, a ingestão total de líquidos foi de 553,14±109,52ml.h^{-1}, a coloração da urina foi de 3,90±0,42 antes do treino e 2,58 ± 0,85 após e a gravidade específica 1.018,04 ± 2,13 e 1.010,38 ± 3,23, respectivamente. A variação da massa corporal foi de 0,07%, após uma reposição hídrica de 8,27±51,62% acima das perdas hídricas totais. Concluiu-se que o treinamento de natação não potencializou o estado de desidratação e que a ingestão de líquido "*ad líbitum*" foi suficiente para minimizar o estado de desidratação verificado antes do treinamento.

Palavras-chave: natação, gravidade específica, coloração da urina.