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Effect of Acute Moderate-Intense Aerobic Exercise on the State of Hydration and Sweat Rate of Trained Individuals.

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ABSTRACT

Background: The practice of moderate-intense physical exercise in environments with high temperatures causes water loss through sweating. This may promote dehydration, which if not controlled, will hamper the regulation of body temperature. Thus, causing a reduction in physical performance and lead to life-threatening medical conditions. This study aimed to verify the effect of an acute bout of moderate-intense physical exercise on hydrate state and sweat rate of trained individuals. **Results:** The mean hydration status was -0.17 ± 0.48%, 0.58 ± 0.30% and -1.0 ± 0.16%, for WG, CG and NWG, respectively. For state of hydration, NWG presented a significant difference compared to the CG and WG ($p<0.05$). The calculation of the sweat rate demonstrated significant difference between the WG and NWG when compared to the CG. **Conclusion:** The ad libtum water intake demonstrated fundamental role in maintaining the sample in the hydration status of I-hydrated.

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INTRODUCTION

Water is an extraordinary and omnipresent nutrient. Maintenance of a relatively constant volume of a stable composition of body fluids is essential for a good homeostatic control. Fluid intake is highly variable and need to be carefully counterbalanced to prevent any large variation of the volume of bodily fluids (Armstrong *et al*. 2014). The fluid loss through sweating is very variable and can depend on environment temperature, relative humidity and type of physical activity (O´Neal *et al*. 2013).

Intense physical exercise can induce a radical increase in metabolic rate (Vincent *et al*. 2015). Chemical reactions of energy metabolism increase body heat production, reaching considerable levels during extraneous exercise practice. Thus, the heat loss is determined almost exclusively by two factors: (1) how quickly heat is carried from their site of production to the skin and (2) how quickly heat is transferred from the skin to the environment.

In physical activities and long-term training, hydration must be constantly carried out to maintain water homeostasis (Maughan and Meyer, 2013). Although there is consensus on the need for fluid intake during physical activities, constantly observed that most of the athletes does not have the habit of moisturizing (Ferreira *et al*. 2010).

Among the main concerns about intense workouts, we can include dehydration, reducing plasma volume, and deterioration of physical performance and thermoregulation capacity (Maughan *et al*. 1997). Starting from observations that dehydration is one of the main risks to the subject during exercise practice; the need to replace water loss has become established and spread in many international consensus. Thus, this study aimed to compare the effect of an acute bout of moderate-intense physical exercise on hydrated and non-hydrated status of trained individuals.

MATERIALS AND METHODS

Sample:

This study included thirty male volunteers who were randomly divided into three groups: water group (WG), without water group (NWG) and control group (CG).

Participants voluntarily signed the free and informed consent. The Research Ethics Committee of the University of Taubaté - CEP / UNITAU (# 303/11), approved the research.

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To characterize the sample, we measured skinfold thickness (sub scapular, brachial triceps, chest, midaxillary, supra-iliac, abdominal and thigh), body mass index (BMI) and maximal oxygen uptake (VO2 max). We use the caliper of Sanny® mark for investigation of cutaneous folds. The relative body fat (fat%) was determined by the formula of Siri (1961) from the estimation of body density (DENS) by the equation of 7 skinfolds from Jackson and Pollock (1978). The calculation was made from the following formula:

DENS = for men from18 to 61 years of age; EPE=0,008 r:0,90;

DENS = 1,11200000 - [0,00043499 ($\sum$ 7 ST)] + [0,00000055 ($\sum$ 7 ST)²] – [0,00028826 (age)]

Fat% = [(4.95 / DENS) – 4.50] X 100.

The Body Mass Index (BMI) was calculated by body weight (BW) divided by height squared (BW / height²) (QUEIROGA, 2005).

The VO_2max was determined from the results of the 12-minute run test. To get to the VO_2max we used the Kenneth and Cooper protocol (1968).

VO_2máx (mL/Kg/min) = (D - 504,094)/44,783.

Where D = distance in meters traveled in 12 minutes.

Weighing (Líder® scale) was performed with the individual dress only swim trunks, and the measurement of height were measured with tape prefixed with a maximum height of 2.50 meters. All volunteers did ingesting 500 ml of water (Nestle), two hours before the start of activities (ACSM, 1996). Al data is shown in table 1.

Table 1: Sample characteristics (data showed as mean ± SD).

Groups	Age (years)	Fat (%)	BMI (kg/m^2)	VO_2 max (ml.kg.min^{-1})
WG	22,3 ± 2,3	10,9 ± 2,9	23,3 ± 2,9	53,5 ± 1,5
NWG	24,3 ± 3,9	9,7 ± 2,6	22,5 ± 1,9	52,6 ± 1,9
CG	24,7 ± 2,6	10,9 ± 2,2	23,3 ± 2,0	52,6 ± 1,3

Exercise Protocol:

The WG and NWG ran for 30 minutes at a predetermined intensity between 70-90% VO_2 max (average temperature of 29ºC and 41% relative humidity). The WG group was instructed to fluid intake at will (ad libitum). During the activity, WG received a bottle of mineral water containing 510ml. When the bottle was empty, we quantified the volume of 510 ml (V = 510 ml). After words, a new bottle of water, identified with the name of the volunteer, was delivered. We approached this procedure to make sure that no water ad libitum would lack. Moreover, NWG received no water bottle during physical stress. Once finished the exercise, we measured the water balance (Vr) for each bottle, using a 750 ml beaker up (accuracy 1 ml). The volume of water ingested (Vi) during exercise was calculated as follows:

Vi = V + (510 - Vr).

At the end of activities all groups emptied the bladder in a container with a maximum volume of 510 ml identified with the name of each volunteer. Then all the volunteers were submitted again to the weighing, and checked the body mass after exercise. Immediately after this, the quantification of the final urine volume was made (Vu) using a beaker numerical degree to 750 ml for checking the state of hydration (table 2) of the volunteers and to check the sweat rate. Data were analyzed using established protocol by the National Athletic Trainers' Association (Casa *et al*. 2000). State oh hydration and sweat rate was calculated from following formulas:

% body weight variation = [(pre exercise body weight – post exercise body weight) / pre exercise body weight] X -100.

Sweat rate = (ΔBW + Vol H_2O – Vol Urinary) / exercise time.

Table 2: Hydration state index.

Hydration state	% Δ body weight
I-hidration	+1 to -1
Minimum dehydration	-1 to -3
Meanfull dehydration	-3 to -5
Serious dehydration	> -5

Statistical analysis:

To check the assumption of normality in the distribution of variables of interest, we used statistical test Shapiro-Wilk. Since the dependent variable showed that distribution could be approximated by the normal distribution, we chose to describe the data averaging, as estimator of central tendency point and the standard deviation, as estimator of the average dispersion. We employ the mixed analysis of variance in a 2 × 3 design, to assess the significance of the difference between all the contrasts, and then used the post-hoc Tukey test. It was established $p \leq 0.05$ for define statistical significance.

Results and Discussion:

All groups showed variation in their body mass due to physical and thermal stress (WG and NWG) or only heat stress (CG) [Table 3].

Table 3: Description of body mass (kg) behavior between groups and times (data presented as mean and standard deviation).

Groups	CG	NWG	WG
Pre exercise	70.74 ±9.28	65.29 ±8.38	73.56 ±12.63
Post exercise	70.33 ±9.25	64.63 ±8.28	73.42 ±12.59
Delta (%)	- 0.58 ±0.30	-1.00 ±0.16[a,b]	- 0.17 ±0.48[c]

[a]Indicates a statistically significant difference from the control group (P = 0.0295). [b]Indicates statistically significant difference from the water group (P = 0.0001). [c]Indicates statistically significant difference from the control group (P = 0.0317).

According to the data presented in Table 4, the control group presented fewer sweat rate and was statically different from NWG (Δ = -8.13 [-15.91, -0.35] ml • min-1) and WG (Δ = -12.67 [-20.44, -4.89] ml • min-1).

Table 4: Description of the sweat rate (ml.min^{-1}) between the control group (CG), without water (NWG) and water (WG).

Groups	CG	NWG	WG
Sweat rate	12.19 ± 6.4	20.32 ± 4.35[a]	24.86 ± 9.36[b]

[a]Indicates a statistically significant difference from the control group (P = 0.0390). [b]Indicates statistically significant difference from the control group (P = 0.0011).

Vasconcellos and Meirelles (2011) showed reduction of 1.3 ± 0.2% (1.0 ± 0.2 kg) of body weight of athletes during a race of 10 km (47 ± 4 min) even after they have undergone a hydration protocol 400 ml / hour. Concerning the state of hydration after acute exercise, NWG had significant dehydration comparing it to the other groups out, what features a minimum average dehydration state of - 1.00 ± 0.16.

Comparing the sweat rate between the groups, we demonstrated that the greater amount of water intake presented higher sweat rate. Other studies had shown the same results as ours even when environmental temperature was higher (Son *et al*. 2014). These results shown that fluid replacement is important to keep individuals hydrated and to the thermoregulatory mechanisms continued to function. In the study by Vasconcellos and Meirelles (2011), the sweat rate was 6.0 ± 1.3 ml / min, corresponding to a total of 358 ± 79 ml/h, which was below the water intake, leading to one 52 ml bonus and featuring a 117% hydration.

In the study of Vimieiro-Gomes and Rodrigues (2001), hydration ad libitum promoted a hydration of 59% compared with the loss of sweating leading to a percentage of dehydration -0.9 ± 0.6. These values do not characterize significant dehydration, as it kept volunteers within a state I hydrate.

According to Moreira and Gomes (2006), it seems to be coherent that the intake of water according to thirst is sufficient and more suitable. We believe that the central nervous system is able to correctly indicate the volume of fluid to be ingested from information integrated by it about all the body's demands. Furthermore, it is important to consider the development of the scheme's headquarters as part of the evolutionary process of the human being, which developed over time different mechanisms and seamlessly integrated to adjust the volume and plasma osmolality as well as your body temperature.

Considering the current discussions on the possible risks related to excess hydration during exercise believe that there was a water intoxication leading to low serum sodium levels (hyponatremia), some authors have advocated the effectiveness of fluid intake according to thirst, that is, voluntary intake of liquids, such as safe strategy for fluid replacement.

Conclusion:

The maintenance of water levels in the body through the fluid intake is essential for physical activities, whether severe or not, on a hot, humid environment. There were significant differences in the hydration status between these two groups, showing that the group that did not fluid intake during exercise changed their hydration status. Furthermore, the sweat rate was determined in proportion to the amount of water consumed, taking into account the hydration ad libitum, showed to be enough to keep the volunteers in a great hydration state even at elevated climatic conditions.

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