



## Influence of Physical Exercises on Salt Loss and Sweat Rate Level

### KEYWORDS

Physical Exercise, Sweat sodium, sodium chloride and sweat rate.

### Dr. SUGUMAR.C

Deputy Director of Physical Education, Gandhigram Rural Institute – DU, Gandhigram, Dindigul-624 302, TamilNadu

**ABSTRACT** *The study was intended to investigate the influence of physical exercises on sweat sodium, sodium chloride, sweat rate and percentage of loss of body mass level. For the purpose of the study, twelve men players were selected as subjects. All the subjects participated in one trail run a motorized treadmill to 16 minutes duration. Subjects ran at 4km/h for first 1 minute duration and at 70% target heart rate for next 15 min. After the treadmill run the sweat samples were collected from the subjects. The collected data were statistically examined by using simple correlation to determine the association among the sweat Na, NaCl, sweat rate and percentage of loss of body mass. The present study suggested that, there was a significant association among the selected variables.*

### Introduction

Approximately 70% of total body weight is water. Water is the most important nutrient, involved in almost every vital body process. It is essential for maintaining body temperature, transporting materials, and assisting with chemical reactions. A person should consume water 2 to 3 times a day by

drinking fluids and through the water contained in fruits and vegetables with excess sweating (e.g during exercise and hot, humid weather) a large amount of water is lost. In such cases it is important to consume large quantities of water to remain hydrated (Robergs and Reberts, 1997).

Every healthy person secretes sweat. One interesting study raises a possible link between low sweating (genetic) and a greater chance of asthma after effort (Park, et al., 2008). Sweat is also a metabolic process that allows the removal and balance of substances in the body. It removes pollutants from the human body along with the processes of urination and the excretion of feces. It balances the concentration of salts in the body. Many studies in scientific journals research the control of secretions in sweat: metals, salts and various other materials. There are still many unknown mechanisms but no doubt this is a process which our body knows how to use in order to remove pollutants, such as nitric waste, and / or salts from the body. Sweat contains mainly water and minerals such as urea. The contents of the sweat depends on a specific person, the environment the person is in (in hot areas there will be more sweat and the concentration of salts will decrease thus saving the correct concentration of salts in the body) (Stauber and Florence, 1988 and Buono, et al., 2007).

During heavy physical activity, particularly on hot and / or humid days large quantities of water and some salt are lost by the body through sweating. If water and salt are not replaced within a 24 hours period, dehydration and heat illness may result. Although replacement of water is for the more serious requirement, the poorly informed person is concerned more with the taking of salt tablets (to replace salt) than with the drinking of water (Bowers, 2001). Most sports medicine professionals believe the incidence of heat illness can be reduced with proper hydration, an idea strongly supported by the National Athletic Trainers' Association position statements on fluid replacement (Casa, et al., 2000) and exertional heat illness (Binkley, et al., 2002).

Dehydration (determined by how quickly fluids are lost via sweating combined with inadequate fluid intake) is considered one of the primary precursors to heat-related disorders

(Casa, et al., 2000 and Binkley, et al., 2002). Physical characteristics such as total body mass, lean muscle mass, percentage of body fat, body surface area, and surface area-to-mass ratio affect thermoregulation. Aerobic fitness, acclimatization, clothing and equipment worn, and environmental considerations can contribute to the incidence of heat illness (Casa, et al., 2000). Although sweat rates vary widely from one athlete to another, the average-sized male athlete generally sweats at a rate of between 0.75 and 1.75 L/h (Broad, et al., 1996 and Millard-Stafford, et al., 1995).

The sweat composition undoubtedly varies among individuals; it can also change within the same individual depending on the rate of secretion, the state of training and the state of heat acclimatization. When an individual is dehydrated by a little as 1-2% of body mass and that loss in excess of 5% of body mass can decrease the capacity for work by about 30%. The main function of sweat is to maintain body temperature. In visible perspiration accounts for about 600-700 ml/day and consists of almost pure water. Visible perspiration in hot and mild conditions may contain much of Na<sup>+</sup> and Cl<sup>-</sup> lactic acid is also present in substantial amounts. The only means for heat loss at temperature above skin temperature is by evaporative sweating, sweating is an effective cooling mechanism. The capacity for sweating differs between individuals. If an individual is acclimatized to heat the amount of sweat related to more heat will increase.

"when sweating is excessive and the goal is to restore fluid losses during exercise, special attention should be paid to the replenishment of sodium". The data presented indicate that the goal of rehydration during exercise is not to replenish fluid losses but rather to maintain [Na<sup>+</sup>]. This is best accomplished by drinking to thirst, (Noakes, 2007), does not require sodium supplementation, (Speedy, et al., 2002), and is usually accompanied by mild to moderate weight loss (Noakes, et al., 2005).

### Aims and Objectives of the Study

Numerous studies have shown that following heat acclimation, there is a large increase in the secretory capacity of the eccrine sweat glands (Buono, et al., 2007, Garden, et al., 1966, Mitchell, 1976, Pandolf, 1988). For example, chest and forearm sweat rates have been reported to increase 110% following heat acclimation using a controlled-hyperthermia protocol, in which the work rate was adjusted to achieve and maintain an elevated core temperature (Patterson, et al., 2004). Fox et al., (1964) and Collins et al., (1966) concluded that the increased sweating capacity associated with heat ac-

climation was a direct result of sweat gland activity during the heat exposures and was not dependent on an elevated body temperature. Based on the above facts the objective of the present study was framed i.e. influence of physical exercise on salt loss, sweat rate level and percentage of loss of body mass.

**Methodology**

To achieve the purpose of the study 12 players were selected as subjects and their age ranges from 18 to 25 years. All the measurements were made on 1 day of the evaluation on a motorized treadmill run for 16minutes duration. The trail was given in random order. All the subjects arrived at the physiology laboratory in the morning after took bath for 5 min duration. The testing arena temperature and relative humidity was 34.3°C and 88.5% respectively. Subjects then ran at treadmill speed (of 4 km /min) for first 1min for warm-up and at 70% intensity was fixed and its depends upon the individuals target heart rate until 16 min. Sweat samples were collected after the 16<sup>th</sup> min from the subjects body sweat. The players were encouraged to drink normally and had free access to their chosen drink in individually labeled water bottles. All the bottles were weighted before and after the treadmill run to determine each individual's total fluid intake. Players were instructed to drink only from the bottles provided and not to spit out any of the fluid. Sweat sodium concentration was measured by lab test the sodium (Na). Sodium chloride (Nacl), percent body mass loss and sweat rate was calculated by using the following formula.

$$\text{Sodium concentration} \times 22.99 \times \text{Sweat loss}$$

$$\text{Sodium Loss} = \frac{\text{Sodium concentration} \times 22.99 \times \text{Sweat loss}}{1000}$$

$$\text{Sodium Chloride Loss} = \frac{\text{Sodium loss} \times 58.44}{22.99}$$

$$\text{Percentage of loss of body mass} = \frac{(\text{Pre body mass} - \text{Post body mass})}{\text{Pre body mass}} \times 100$$

$$\text{Sweat rate} = \frac{(\text{Pre body mass} - \text{Post body mass}) + \text{Fluid intake} - \text{Urine output}}{\text{Practice Length}}$$

**Statistical Analysis**

All data are presented as the mean ± SD. Association between variables was investigated by using Pearson's Correlation analysis. Statistical significance was accepted at p<0.05.

**TABLE I: MEAN AND STANDARD DEVIATION ON SELECTED VARIABLES**

Variables	Mean	SD	Minimum	Maximum
Height (cm)	170.17	5.19	161	178
Resting Heart Rate (beats/minute)	69	5.78	58	78
Na (mEq/L)	3.283	2.30	0.39	7.06
Nacl (mEq/L)	8.35	5.85	0.98	17.94
Sweat Rate (L/hr)	0.042	0.07	0.02	0.06
% Body Mass Loss (Kgs)	1.17	0.54	0.44	1.89

**TABLE II ASSOCIATION BETWEEN THE SELECTED VARIABLES**

Variables	Na	Nacl	%body mass Loss
Sweat Rate	0.929*	0.929*	0.967*

\* Significant at 0.05 level.

(Table value required for 0.05 level of significance with df 10 is 0.576).

**Results**

Due to the effect of physical exercise with respect to the testing arena temperature and relative humidity was 34.3°C and 88.5% which affect the sweat composition. Sweat rate is correlate with the Na loss (r = 0.929), Nacl loss (r = 0.929), and percentage of loss of body mass (r = 0.967).

Due to the influence of physical exercise, there was a significant association among the sweat sodium, sodium chloride losses, sweat rate and percentage of loss of body mass (Buono, et al., 2007 and Montain, 2007).

**Discussion**

In humans, increasing the sweating rate is the main way of dissipating excess heat from the body during exercise in a warm environment, since the evaporation of sweat is the only way to lose heat when the ambient temperature is higher than the skin temperature. The main thermal factors associated with regulation of the sweating response are changes in the core and skin temperatures (Kondo et al. 1998). In addition, sweating response may be modulated by several non-thermal factors: (1) peripheral mechanisms activating the mechanosensitive (Kondo et al. 1997) and metabosensitive receptors in the exercising muscles, (2) central command signals linked with volitional effort (Vissing, 1997), and (3) emotional and mental stimuli (Ogawa, 1975). The results of the study may depend upon the following factors related to human physiological system: While performing heavy exercise in hot climate the body can lose more than 1L of sweat per hour per square meter of body surface. A high rate of sweating reduces performance potential, particularly for endurance activities. During light sweating, the filtrate sweat travels slowly through the tubules, allowing time for almost complete reabsorption of Na<sup>+</sup> and cl<sup>-</sup>. Thus the sweat that forms during light sweating contains very little of these mineral by the time it reaches the skin. In citing Greenleaf and Sargent's seminal 1965 work, the authors noted that "thirst perception is an insufficient means to match fluid losses during exercise." This is true, although the goal of exactly matching fluid losses during exercise is unclear. It is well established that exercising humans replace a fraction (20%–70%) of sweat losses when given ad libitum access to fluids (Saunders , et al., 2005). Recent work has demonstrated maintenance of total body water despite weight loss of 4%–5% during the prolonged exercise of an ultradistance triathlon. The correlation with body-weight loss and maintenance of physiologic [Na<sup>+</sup>] is well established (Noakes, et al., 2005). Sharwood et al., 2002, demonstrated that large losses of body weight in an ultradistance triathlon correlated with neither decreased performance nor likelihood of presenting to medical stations.

**Conclusion**

The present study was concluded that

1. Due to the influence of physical exercises, salt loss (Na<sup>+</sup> and cl<sup>-</sup>) depended upon the sweat rate and percentage of loss of body mass.
2. The present study recommends that, athletes performing the physical exercise they must replenished with sports drink during the physical exercise.
3. Similar study could be conducted with more subjects on a more elaborate and extensive manner to cover all age groups.
4. The results of this study may help the coaches and teachers to understand the electrolyte loss during the physical

## REFERENCE

- [1] Binkley HM, et al.,(2002), "National athletic trainers' association position statement: exertional heat illness- es." *J Athl Train.*, 37, 329-343. | [2] Bowers Richard W., (2001), Sports srinks, Campaign: Illinois: Human Kinetics Publishers Inc. 299. | [3] Broad EM, et al., (1996), "Body weight changes and voluntary fluid intakes during training and competition sessions in team sports." *Int J Sport Nutr.* 6, 307-320. | [4] Buono MJ, et al.,(2007), "Sodium ion concentration vs.. sweat rate relationship in humans." *J Appl Physiol.*, 103 (3), 990-4. | [5] Casa DJ, et al., (2000), " National athletic trainers' association position statement: fluid replacement for athletes." *J Athl Train.*, 35, 212-224. | [6] Chen WY and Elizondo RS. (1974), "Peripheral modification of thermoregulatory function during heat acclimation." *J Appl Physiol.*, 65, 811-814. | [7] Collins KJ, et al., (1966), " The local training effect of secretory activity on the response of eccrine sweat glands." *J Physiol.*, 184, 203-214. | [8] Fox RH, et al., (1964), " The nature of the increase in sweating capacity produced by heat acclimatization." *J Physiol.*, 171, 368-376. | [9] Garden JW, et al., (1966), "Acclimation of healthy young adult males to a hot-wet environment." *J Appl Physiol.*, 21, 665-669. | [10] Kondo N, et al., (1997), "Sweating responses to passive and active limb movements." *Journal of Thermal Biology*, 22, 351-356. | [11] Kondo N, et al., (1998), "Regional differences in the effect of exercise intensity on thermoregulatory sweating and cutaneous vasodilation." *Acta Physiol Scand.*, 164(4), 71-8. | [12] Millard-Stafford M, et al.,(1995), "Fluid intake in male and female runners during a 40-km run in the heat." *J Sports Sci.* 13, 257-263. | [13] Mitchell D, et al., (1976), "Acclimation in a hot, humid environment: energy exchange, body temperature, and sweating." *J Appl Physiol.* 40, 768-778. | [14] Montain SJ, et al., (2007), "Sweat mineral - element responses during 7h of exercise -heat stress." *Int J. Sport Nutr Exerc Metab*, 17(6), 574-82. | [15] Noakes T. D.(2007), "Hydration in the marathon: using thirst to gauge safe fluid replacement." *Sports Med.* 37(4-5), 463-436. | [16] Noakes T. D., et al., (2005), "Three independent biological mechanisms cause exercise-associated hyponatremia: evidence from 2,135 weighed competitive athletic performances." *Proc Natl Acad Sci.*, 102(51), 18550-18555. | [17] Ogawa T, (1975), "Thermal influence on palmar sweating and mental influence on generalized sweating in man." *Jpn J Physiol.* 25(4), 525-36. | [18] Pandolf KB, et al., (1988), "Thermoregulatory responses of middle-aged and young men during dry-heat acclimation." *J Appl Physiol.*, 65, 65-71. | [19] Park C, et al., (2008), "Exercise-induced asthma may be associated with diminished sweat Secretion rates in Humans," *Chest*, 134 (3), 552-8. | [20] Patterson MJ, (2004), "Humid Heat acclimation does not elicit a preferential sweat redistribution toward the limbs." *Am J Physiol Regul Integr Comp Physiol.* 286, 512-R518. | [21] Robergs Robert A., and Robert, Scott O. (1997), *Exercise Physiology, USA* : Mosby Year Book Inc. 750. | [22] Saunders A. G., et al., (2005), "The effects of different air velocities on heat storage and body temperature in humans cycling in a hot, humid environment." *Acta Physiol Scand.*, 183(3), 241-255. | [23] Sharwood K, et al.,(2002), "Weight changes, sodium levels, and performance in the South African Ironman Triathlon." *Clin J Sport Med.* 12(6), 391-399. | [24] Speedy D. B., et al., (2002), "Oral salt supplementation during ultradistance exercise." *Clin J Sport Med.*, 12(5), 279-284. | [25] Stauber JL, Florence TM., (1988), "A comparative study of copper, lead, cadmium and zinc in human sweat and blood." *Sci Total Environ.*,74, 235-47. | [26] Vissing SF, (1997), "Review Differential activation of sympathetic discharge to skin and skeletal muscle in humans." *Acta Physiol Scand Suppl.* 639, 1-32. |