Australian Journal of Basic and Applied Sciences, 1(4): 687-690, 2007
ISSN 1991-8178

A Survey of Sodium and Potassium Alterations during Rest Time after Aerobic Activities in Athletes

[1]M. J. Pourvaghar and [2]R. Soori

[1]Department of Physical Education, University of Kashan, Kashan, I.R. Iran.
[2]Department of Physical Education, University of Tehran, Tehran, I.R. Iran.

Abstract: The aim of this research has been the investigation of student athletes rest time sodium and potassium variations. For this purpose, 14 students were chosen to take part in this research project. The means and standard deviations of their height, weight, age and body mass index (BMI) were respectively: (175±5.9), (68.27±9.89), (19.56±1.16), (22.08±2.47). Participants trained with incremental continuous ruining program for 16 sessions with certain and pre-adjusted heart rate intensity and distance. Heart rate intensity was controlled by polar clock. Blood samples were taken from subjects in pre- and post - test in rest condition. Test of running - jugging were performed for determining maximal oxygen consumption (Vo2 max) of subjects. The analysis of data by SPSS software and paired - sample t test showed that the subjects` serum sodium was significant after even 24 hours of rest (P=0.006). That may be related to loss of water and fluids of body in the last sessions of training. Also serum potassium came to its base state in post - test and was not significant (P=0. 16). That has been probably for return of extra cellular potassium to intracellular. Mean while, Vo2 max of subjects was significant after 16 sessions (P=0.0001).

Keywords: Sodium, potassium, running - jugging test, aerobic activity

INTRODUCTION

Sodium is the major cation of the extracellular fluid. A reduction in the extracellular sodium concentration will result in a fluid shift into intracellular space, which can lead to cellular swelling and its associated complication (DER. Warburton, *et al.,* 2002). It is overall eight to 10 times more concentrated in the extracellular than in the intracellular space. The sodium concentration gradient across the cellular membrance and the transmembrance sodium fluxes are regulated by the sodium-potassium pump, which plays an important role in cellular processes (D. Chrise, *et al.,* 2000). Several hyponatremia (sodium < 130 mmol/l) has been associated with several complications, including mild symptoms, such as malaise, nausea, fatigue and confusion. Hyponatremia is seldom observed in athletes after four hours of exercise (DER. Warburton, *et al.,* 2002). Several possible mechanisms have been postulated to lead to exercise induced hyponatremia (SJ, Montain,*et al.,* 2001). Some investigators have speculated that sodium chloride losses in sweat associated with net dehydration may lead to the observed hyponatremia after prolong strenuous exercise (DER. Warburton, *et al.,* 2002).

Alteration in total sodium content and in transmembrance sodium flux rates occurs in numerous normal and disease conditions, including exercise muscle (D. Chrise, *et al.,* 2000).

Hyponatremia develops when both sodium and fluid are lose in sweat, the loss of 120 mmol of sodium and 1 L of fluid from the extracellular fluid (ECF), corresponding to a fluid loss of 3 L from the total body water, will cause the serum sodium concentration to rise to 141 $mmol.l^{-1}$. (T. Noakes and MB Chb, 2002). If the ECF volume decreases by 1.5 liters rather than 1 L, the serum concentration will raise to 146 $mmol.1^{-1}$(T. Noakes and MB Chb, 2002). The historic data prove that dehydration and unreplaced sodium losses during prolonged exercise cause hyponatremia (T. Noakes and MB Chb, 2002).

On the other hand, potassium, the major cation of the intracellular fluid, is released from muscle cells during exercise in direct relation to exercise intensity (C.W. Barlows, *et al.,* 1994; D. Chrise, *et al.,* 2000; D. Street, *et al.,* 2005). A rise in potassium (hyperkalaemia) is rapidly reversed after rest from exercise and many even associated with a lowering of potassium levels to below control levels (hyperkalaemia) (DER. Warburton, *et al.,* 2002). The resultant of hyperkalaemia may also be due to increased blood flow to

Corresponding Author: M.J. Pourvaghar, Department of Physical Education, University of Kashan, Kashan, Iran.

the skeletal muscles and/or increased intracellular acidos (DER. Warburton, *et al.,* 2002). Barlow *et al* (1994) showed that the exercise-induced rise in potassium and ventilation are greater at matched sub maximal work rate in subjects with normal left ventricular function (C.W. Barlows, *et al.* 1994). Another study showed that the exercise-induced rise in potassium at matched sub maximal work rate tended to be greater in severe chronic heart failure, but it did not reach statistical significance (Y. Tanabe, *et al.,* 1999). The Δk^{+} from rest to peak exercise was correlated with peak vo2. The amount of potassium related into the circulation from the muscle is dependent on the magnitude of muscle contraction, as reflected by absolute workload (NK. Vollestad, *et al.,* 1994).

The observation suggested that accumulation of extracellular potassium might be important for the development of fatigue in human muscle (J.J. Nielsen, *et al.,* 2004; DER. Warburton, *et al.,* 2002).

Mc kenna *et al* (1997) found that the femoral arterial venous potassium difference. During intense cycle exercise was the same before and after training, suggesting that release of potassium to the blood stream was not changed by the training (SJ, Montain, *et al.,* 2001).

In another research, kiens and saltin (1986) observed that 8 weeks of one-legged endurance training (2h) reduced potassium release during exercise. Furthermore, the rise in plasma potassium in dogs induced by exercise was lower in dogs that had performed endurance training. Apparently, the intensity and duration of the exercise during training affects the potassium release during exercise (B. Kiens, and B. Saltin, 1986). It is, however, unclear to what extent training affects Na+ and K+ how such changes may influence muscle interstitum potassium kinetics and performance. It is, however, not clear whether training induces changes in the amount of K+ and Na+ in rest and in exercise.

MATERIALS AND METHODS

In this semi – experimental research, the effect of 16 sessions of incremental continuous running on sodium and potassium concentration level of athletic subjects` rest time serum and maximal oxygen consumption (Vo2 max) was studied. The subjects of this study were 14 students that had at least 3 years of experience in various trainings. The Means and standard deviations of their height, weight, age and body mass index (BMI) were respectively: (175±5.9), (68.27±9.89), (19.56±1.16), (22.08±2.47).

Training Protocol:

To evaluate rest time values of serum and potassium, in first stage, blood samples were taken from subjects at 8 in the morning on fasting condition, and exactly before the start of main program of research. After wards, 12 minutes running – jugging test were performed to determine Vo2 max.

After 24 hours of rest, the main training was program performed on Sunday and Tuesday of every week for 16 sessions with certain distance and heart rate (Table No. 1). Subjects warmed up for 15 minutes before each session. 24 hours after last training session, the second stage of blood sampling was performed to measure the rest time serum potassium and sodium conditions. After wards, the 12 minuet running – jugging test was performed too.

- To determine the subjects` maximum heart rate formula 220 – age (year) was used.
- To determine the training intensity polar clock (PU-801) (Made in Japan) was used.
- For statistical analysis SPSS software and for drawing charts Word 2003 was used.
- To find differences between means paired-sample t test was used.
- To determine sodium and potassium serum French Hycel system and Flame Photometry were used.

Table 1: Training Protocol designed for subjects.

Training session	Session distance (m)	Train Intensity*	Heart beat (min)
1 to 4 sessions	2000	70 - 75	140 - 150
5 to 8 sessions	2400	75 - 80	150 -160
9 to 12 sessions	2800	80 - 85	160 -170
13 to 16 sessions	3200	85 - 90	170 - 180

* maximum percent of heart rate

Determination of Maximal Oxygen Consumption (Vo2 max):

Blood sampling finished at 8 a.m. Also, variables of height, weight and blood pressure were measured and recorded by a physician (Table NO. 2). Then, a 12 minute running – jugging test to determine Vo2 max, was performed. This test has been designed to measure the distance covered during 12 minutes. The subjects were asked to run as much as they could during 12 minutes; however, they were allowed to walk. The aim of this

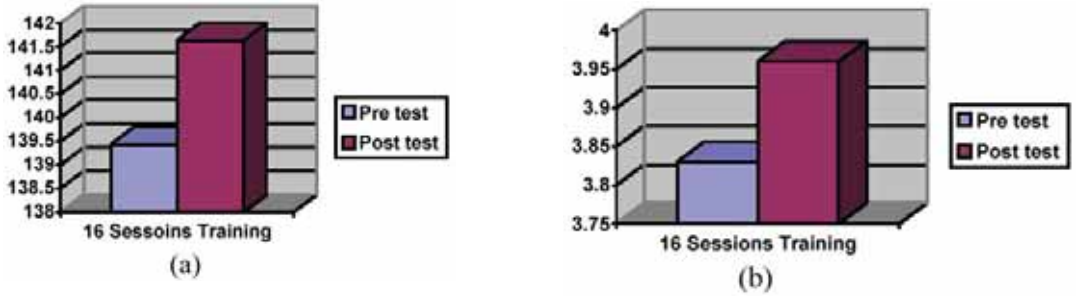

Chart: The changes of serum (a) sodium and (b) potassium before and after exercise in rest time condition.

research has been to traverse the maximum possible distance during 12 minutes. The measurement unit was meter. To find the subjects` Vo2 max the following equation was used: Vo2 max ($ml.kg^{-1}.min^{-1}$) = [0.0268 + (D)] −11.3

RESULTS AND DISCUSSIONS

In Table No. 2, the means of subjects, standard Deviations of descriptive variables have been showed. In Table No. 3 the subjects` rest time serum sodium and potassium variables and t and P values have been showed.

Table 2: Descriptive indexes, means and standard deviations of subjects (N=14).

Statistical Index	Mean	Standard Deviation
Weight (Kilogram)	68.21	9.89
Height (Centimeter)	175.5	5.90
Age (Year)	19.56	1.16
Body Mass Index	22.08	2.47

Table 3: Statistical variables of subjects in pre - and post – test, P and t values.

Variables	Mean pre-test	Mean post-test	t Value	P Value
Sodium (mEq/L) **	139.43±1.58	142.64±2.47	3.29	0.006
Potassium (mEq/L)	3.83±0.27	3.96±0.23	1.49	0.76
12 Minutes running-jugging (m)	2247.14±147.84	2440.71±119.79	4.88	0.0001
Vo2 max (ml/kg/min)	48.92±3.96	54.11±3.21	5.48	0.0001

** It is significant in lower than 0.01 level.

As observed in table 3, Serum sodium concentration level has had significant difference in pre - and post - test in rest time condition after 2 months of training (P=0.006, df =13 and t=3.29).

Serum potassium concentration levels among subjects after 16 sessions of incremental continuous running and in rest time condition was not significantly different. (P=0.16, df =13 and t=1.49).

On the other hand, comparing subjects` running-jugging test means showed significant differences after 16 sessions of training (P=0.0001, df =13 and t=4.88).

Also, comparing subjects` maximal oxygen consumption means showed significant difference after 16 sessions of training (P=0.0001, df =13 and t=5.48).

The purpose of this research has been to study serum sodium and potassium concentration variations in rest time condition. To do so, the subjects of research, participated in an incremental continuous running activity (Table No.1). The results showed the sodium and potassium concentrations involved fluctuation even after 24 hours from regular body activity and did not return to its original and base state.

The majority of researches done show that blood serum electrolyte varies just after body activity (D. Chrise, *et al.,* 2000; DER. Warburton, *et al.,* 2002; SJ, Montain, *et al.,* 2001). These variations mostly include continuous and intense activity (T. Noakes and MB Chb, 2002; DER. Warburton *et al.,* 2002).

In this research the subjects, after the last training session, rested for 24 hours. However serum sodium of subjects was significant. Mean concentration of subject's serum sodium increased 2.21 mEq/L in post-test than pre-test. It seems that body activity reduces weight of subjects after regular period of training. In this time, sodium and body fluids decreases by sweating. Over sweating causes more water loss and sodium concentration increase in blood. In this regard, present research corresponds with Noakes (T. Noakes and MB Chb, 2002). Also, it seems intensity and training duration affect sodium response and its concentration. On the other hand, blood sampling time after activity is another important factor after training to determine

sodium concentration. Comparing serum potassium means did not show significant difference between pre - and post - test stages. It seems 0.13 mEq/L increase in potassium concentration shown in chart has been caused by natural variations of serum potassium concentration. In this regard, the present research does not correspond with some researches (C.W. Barlows, *et al.* 1994; Y. Tanabe, *et al.,* 1999).

Furthermore, the subjects` one-day rest time after last training session could return little and non-significant serum potassium increase to its original state. The main factor of non- significant in serum potassium was type of intensity and duration of training and also return of extra cellular serum potassium to intra cellular to normalize this electrolyte condition after 24 hours of rest. In present study, in addition, sodium and potassium variables, 12 minutes running-jugging distance were performed to determine maximal oxygen consumption. Participants in projects ran distances with certain heart rate. 12 minutes running – jugging test was performed before the first session and after the last one. Comparing subjects` traversed distance means showed 2 sessions of training per week with certain heart rate intensity can cause significant difference in Vo2 max of subjects (P=0.0001) that corresponds with most research results such as Garrett Kirkendal (2000) and Kuper.

REFERENCES

C.W. Barlows, D. Qayyum, *et al.,* 1994. Circulation, 89: 1144-1152.

D. Chrise. MSE, Constantindes, S.J. Gillen, G. Pomer and P.A. Bottomley, 2000. Radiology, 216: 559-568.

D. Street, J.J. Nielsen, J. Bangsbo and C. Juel, 2005. J Physiol, 566. 2: 481-489.

JR. Garrett, W.E. Kirkendal, T. Donald, 2000. Exercise and sport scien ce: A wolters Kluwer Company.

J.J. Nielsen, M. Mohr, C. Klarskor, M. Kristensen and P. Krustrup, *e t al.* 2004. J Physiol., 554(3): 857-870.

B. Kiens, and B. Saltin, 1986. Acta Phys. Scand 126,20A.

MJ, Mc Kenna, GJ, Heigenhauser and Rs, Mc Kelvie *et al.* 1997. J Phyiol, 501: 687-702.

SJ, Montain, MN Sawka and CB Wenger, 2001. Exerc Sport Sci Rev, 29: 113-7.

W. Roger and R. Earle, 2004. Thomas Baechle, Essential of personal training national strength and conditioning association: NSCAS Human Kinetic.

T. Noakes and MB Chb, 2002. FACSM, Hyponatremia in distance runners: Fluid and sodium balance during exercise current science, Inc. ISSN 1: 537-890X.

NK. Vollestad and J. Hallen, 1994. Om. Sejerted, 475: 359-368.

DER. Warburton, RC. Welsh, RC. Haykowsky and DA. Taylor, 2002 Human DP, 36: 301-303.

Y. Tanabe, M. Ito, Y. Hosaka, E. Ito and K. Suzuki, *et al.* 1999. Chest, 116: 88-96.