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Effect of Re-Substitution of Body Lost Liquids Consequent Dehydration on Heart Functional Indicators among Male Karate Experts in Tabriz

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Abstract: Fluid intake and adequate hydration during exercise are essential and more importantly, critical during prolonged training sessions and competition events. Fluid intake maintains hydration and helps to maintain body temperature (thermoregulation), avoid dehydration and maintain adequate plasma volume. In order to investigate effects of liquids re-substitution on heart functional indicators among male club karate experts, 36 volunteer karate experts were randomly divided into two treatment and control groups. The treatment group after cardio screen testing (at 9 o'clock a.m.), sat in sauna from 1-3.5 p.m. and about 4-5% weight loss was experienced and the measurement were repeated. Further, the examinees until 7 a.m. of the next day were given the opportunity by using similar kinds of food and liquids to once again substitute the liquids and were again measured body's acute dehydration except in the time of pre-injection stage, heart output, caused significant change in each one of the heart functional indicators (beating volume, time of left ventricle injection, cardiac frequency, mean arterial pressure, double product and weight) and all these changes at a rehydration interval of 14-16 h returned to its previous state ($p<0.05$). At the time interval between weighing and start of the first karate match, all changes resulting from dehydration are retrieved in heart function.

Key words: Re-substitution, liquids, heart, karate, Tabriz, Iran

INTRODUCTION

Fluid intake and adequate hydration during exercise are essential and more importantly, critical during prolonged training sessions and competition events. Fluid intake maintains hydration and helps to maintain body temperature (thermoregulation), avoid dehydration and maintain adequate plasma volume. For events lasting >1 h, athletes should consume fluids containing Carbohydrates (CHOs) and electrolytes rather than water alone.

Reduction in body water availability of CHOs and an inadequate electrolyte balance during prolonged exercise events will hamper performance and may lead in some cases to serious medical problems (heat exhaustion or heat stroke). About 1% reduction in body weight due to water loss may evoke an undue stress on the cardiovascular system accompanied by increases in heart rate and inadequate heat transfer to the skin and the environment, increase plasma osmolality, decrease plasma volume and may affect the intracellular and extracellular electrolyte balance (Convertino *et al*., 1996). Fluid in the body is contained mainly in two areas (compartments). These are the extracellular (fluid outside the cells) and the intracellular (fluid in the red blood cells) fluids. The extracellular fluid is subdivided into interstitial fluid and blood plasma. In humans, body water constitutes about 60% of an individual's body weight with a few minor differences depending on sex, age, training status, percentage of body fat, etc. About 40% of body water is housed in the intracellular fluid. On average, blood volume in an adult accounts for about 7% of a person's body weight or about 5 L.

Blood volume is distributed between plasma (60% of blood plasma) and red blood cells (40%). When these levels are challenged during prolonged training sessions and competition, they will singly or collectively result in reduced performance and in some cases, may cause serious injury, medical emergency or even death. The sequence of physiologic events affecting the loss of water is via breathing, sweating, feces and urine output. During prolonged performance most water is lost in sweat

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especially during high environmental temperatures. About 580 k cal is lost for every liter of sweat that is evaporated (Naghii, 2000). Loss of body fluid can be determined by changes in body weight resulting from exercise. Each kilogram of body weight loss accounts for about 1 L of fluid loss.

Development of sports drinks with appropriate and adequate concentrations of electrolytes and CHOs promotes maintenance of homeostasis, prevents injuries, and maintains optimal performance (Powers *et al*., 1990). Water balance in the body is regulated by various means. Changes in osmotic pressure or circulating blood volume stimulate the osmoreceptors in the hypothalamus and baroreceptors in heart and blood vessels. Water balance also is regulated by several hormones.

The renin-angiotensin-aldosterone system regulates sodium retention and vasopressin (antidiuretic hormone) regulates water retention in kidneys. Vasopressin also participates in thermoregulation in hypohydrated subjects. Atrial natriuretic peptide secreted by the heart participates in water balance regulation. Atrial natriuretic peptide does not participate or only minimally participates in water balance regulation during cold exposure at 10-12°C. However, exposure to a -20°C environment while wearing warm clothing elicits a 2-fold increase in atrial natriuretic peptide. Cold-stimulated atrial natriuretic peptide release has been found to be inhibited by a 3% level of dehydration (Rintamaki *et al*., 1995).

Noakes historically and very eloquently described medical reasons for fluid replacement during marathon running (Noakes, 2003). He addressed several crucial factors that determine the risk of heatstroke, stating that heatstroke is not associated with the levels of dehydration during exercise but more importantly with the rate at which the athlete produces heat and the capacity of the environment to absorb that heat. He further reported that several factors more important than dehydration are responsible for heat stress, heat illness or heatstroke.

One of these factors is determination of when the rate of heat production exceeds the rate of heat loss. The rate of heat production is determined by the athlete's rate of energy expenditure which is a function of the athlete's mass and intensity of effort or running speed. Noakes (2002) further explained that the risk of heatstroke is likely to be greater in athletes who run 10 km races than in marathon runners because the 10 km race pace is faster than the marathon race pace. Thus, marathon athletes should drink *ad libitum* and aim for ingestion rates of about 800 mL h^{-1}. Heavier athletes are also at greater risk for heat-related conditions than are lighter athletes when both run at the same speed. In a different study, Noakes addressed the etiology of hyponatremia in distance runners and fluid and sodium balance during exercise. A clinical condition was described in which altered cerebral function was associated with very low serum sodium concentrations (<127 mML^{-1}). Noakes attributed the condition to fluid overload as a result of voluntary overdrinking and the only factor responsible for hyponatremia of exercise. Severe hyponatremia may cause edema of vital organs, brain and lungs. Noakes pointed out that the cause of hyponatremia is not the ingestion of large quantities of sodium contained within drinks most athletes consume during exercise but the overdrinking that may develop and induce the cerebral edema. It is cerebral edema and not the sodium concentration that causes symptoms of this condition.

High rates of sodium ingestion during exercise reduce the rate of urine production; thereby perhaps increasing the possibility that fluid overload will develop when voluntary overdrinking is combined with high rates of sodium ingestion. Dangers of dehydration during exercise were further addressed by Noakes (1995). He disputed the fact that dehydration is the cause for heatstroke in all cases of collapse in endurance athletes as has been alluded to historically. He further described that there is good evidence that even mild levels of dehydration impair performance.

Much greater levels of dehydration are required to produce renal failure or even death. He suggested that athletes can safely maintain low levels of dehydration by drinking enough but not too much during exercise. Athletes should be aware that very high rates of fluid ingestion (>1.5 L h^{-1}) sustained for many hours can lead to hyponatremia with a potentially fatal outcome. Excessive water intake may evoke signs and symptoms of hyponatremia. Hyponatremia is usually caused by increased intake and retention of dilute fluids concurrent with large losss of sodium through sweat (Frizzell *et al*., 1986). The aim of this study was to survey effect of Re-substitution of body lost liquids on heart functional indicators among male karate experts in Tabriz.

MATERIALS AND METHODS

In this study, 36 volunteer and sane male karate experts were divided into two groups of 18. This study was semi-experimental types of studies. In this study, after eating breakfast (standard contents) at 7 O'clock, 2 h later, ICG test was done from each two groups at 9 o'clock. In continue, the members of experimental group had the opportunity until 4 p.m. to loss the about 4-5% of their body weight. In the meantime, they were to refrain from taking any food or liquids and at 1 o'clock p.m., all experienced severe weight loss in the sauna. The research protocol was designed such that the process of losing weight and fluid resubstituation are according to the athlete's natural weight loss. For this mean, the questionnaires were given to athletes and accurate information was obtained. It was anticipated that approximately 30 min before the 4 p.m., all their weight reach to predetermined values. Then at 4 p.m., ICG were tested from both groups.

Control group were allowed until 4 p.m. to use from water only if they need. The understudying groups were given opportune until 7 a.m. tomorrow to resubstitutes by using of standard food and water. In second day of research within 2 h after eating breakfast, at 9 a.m. both groups were tested. Atrial mean pressure, cardiac output and stroke volume were measured in both groups. After reviewing the normal distribution of data using the KS method to analysis of results obtained from ICG test was used of repeated measurements examinations.

RESULTS AND DISCUSSION

Data related to the atrial mean pressure, cardiac output and stroke volume are shown in Table 1. Overall, results showed that significant differences have been observed in any of the factors measured at different times in the control group. Contrary, there was significant difference among measured factors in experimental group ($p<0.05$). Dehydration yields to decrease in stroke volume. But re-substitution of fluids caused comeback the stroke volume to normal values resulted from dehydration (Fig. 1). Also researcher observed that dehydration and re-substitution had no significant effect on cardiac output (Fig. 2). Dehydration yields to significant decrease in atrial mean pressure (Fig. 3). But re-substitution of fluids caused comeback the atrial mean pressure to normal values resulted from dehydration. Exercise, athletic competition, prolonged workouts and long training sessions in hot, hot and humid or cold environments challenge physiologic function. Dehydration, thermoregulation, fluid balance, rehydration, electrolyte changes, plasma volume and cardiovascular challenges to name a few, accompany most physical activities, exercise, training and competition. This is especially, true during prolonged endurance exercise and competition. Loss of body fluids inherently leads to a performance decrease, especially if the exercise is performed in hot environment. Thus, it is recommended that all individuals who exercise, train and/or compete attempt to rehydrate and replace fluids and electrolytes that have been lost during

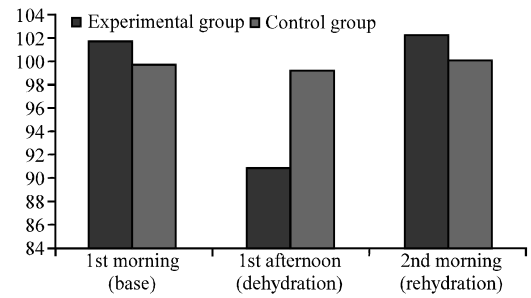

Fig. 1: Comparison of stroke volume in control and experimental group

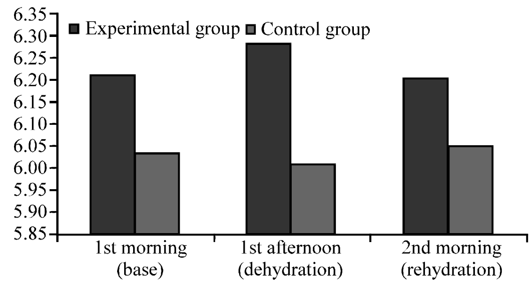

Fig. 2: Comparison of cardiac output in control and experimental group

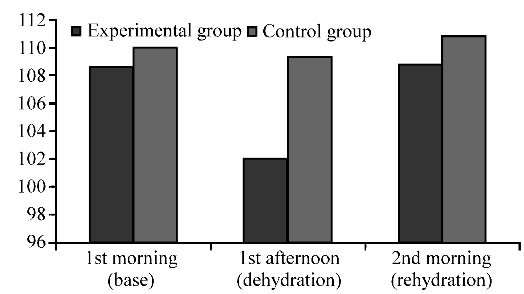

Fig. 3: Comparison of atrial mean pressure in control and experimental group

Table 1: Normal distribution of data measured by using Kolmogorov-Smirnov test

	Experimental group (time)						Control group (time)					
	1st morning (base)		1st afternoon (dehydration)		2nd morning (rehydration)		1st morning (base)		1st afternoon (dehydration)		2nd morning (rehydration)	
Factors	Z	Sig.	Z	Sig.	Z	Sig.	Z	Sig.	Z	Sig.	Z	Sig.
Stroke volume	1.110	0.167	0.712	0.691	0.256	1.010	0.683	0.740	1.006	0.263	0.699	0.713
Cardiac output	0.849	0.467	0.447	0.988	0.687	0.733	0.896	0.398	0.677	0.750	0.561	0.912
Atrial mean pressure	0.568	0.904	0.746	0.634	0.533	0.939	0.444	0.989	0.894	0.402	0.789	0.562

exercise, mostly as a result of sweating. Maintaining proper hydration is not only a physiologic necessity but also adds to a performance advantage and reduces risks of medical problems or injury due to fluid losses. A variety of rehydration protocols have been reported in the literature over the past several years (Costill and Sparks, 1973; Gonzalez-Alonzo *et al.*, 1992; Lambert *et al.*, 1992; Maughan *et al.*, 1994; Mitchell *et al.*, 1994; Ray *et al.*, 1998; Saat *et al.*, 2002) many of which have been designed to investigate the influence of electrolyte content and fluid volume on rapid rehydration.

Conflicting findings regarding the concentration of Na+ in the beverage and volume necessary to produce optimal rehydration have been reported. Variations in the rehydration protocols employed may partially explain these discrepancies (Costill and Sparks, 1973; Gonzalez-Alonzo *et al.*, 1992; Lambert *et al.*, 1992; Mitchell *et al.*, 2000; Nielsen *et al.*, 1986; Nose *et al.*, 1988; Saat *et al.*, 2002; Singh *et al.*, 2002). Although, many studies have employed serial feedings, the protocols typically employed by Gonzales-Alonso *et al.* (1992), Nielsen *et al.* (1986), Ray *et al.* (1998), Saat *et al.* (2002) and Singh *et al.* (2002) involved the ingestion of large volumes (100-120% of fluid losses) and monitoring over a 2 h rehydration period. In the present study, the volume of fluid consumed over the 2 h period was given in a series of feedings every 30 min. This protocol closely resembles ingestion patterns that might be used in actual practice as extreme stomach fullness could be avoided.

On the other hand, studies by Maughan and Leiper (1995), Maughan *et al.* (1994) and Kovacs *et al.* (2002) followed the rehydration process for 5-6 h which provides a more complete picture of the effects of the fluid consumed on kidney function. Studies by Mitchell *et al.* (1994) and Maughan *et al.* (1997) have shown that to maximize rehydration a drink volume greater than that of the body mass lost after exercise should be consumed. In addition, the solution must contain a certain amount of Na+ or other cation sufficient to prevent significant urine production. When Na+ levels in the rehydration drinks are relatively low, even large volumes of fluid consumed do not appear to be adequate to produce rapid rehydration (Shirreffs *et al.*, 1996).

With the ingestion of a fluid with 14 mmol L^{-1} Na+ (volume equivalent to 150% of fluid loss), Mitchell *et al.* (1994), achieved only 73% rehydration after 3 h of rehydration. Maughan and Leiper (1995) showed 5.5 h after ingesting 150% of fluid lost with a Na+ level of 26 mmol L^{-1}, subjects only achieved 80% rehydration. Even with ingesting volumes of 150 and 200% of the loss, Shirreffs *et al.* (1996) reported that full fluid balance was not achieved after 6 h with 23 mmol L^{-1} Na+ solution.

CONCLUSION

After results, it can be said that electrolytes are important elements in the body that heart's normal function is related to them. In dehydration situation because of losses the electrolytes, heart function was disturbed and cannot be act as normally. Thus, such heart functional indicators were affected. For this mean, rehydration after endurance exercise is important for body especially vital organs such as heart, kidneys and brain.

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