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Plasma Catecholamines and Renin Activity in Wrestlers Following Vigorous Swimming

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Summary

Cardiovascular and neuroendocrine responses to exercise in a physically fit and an untrained group of young healthy subjects were compared to study the significance of physical fitness for performance in a discipline for which the athletes were not trained. Ten wrestlers of national rank prepared for an international competition (age 18 years) and 9 untrained healthy males (age 21 years). Exercise consisted of 27-min swimming, freestyle, in water of 29 °C, with last 3 min increased to maximal effort. The blood pressure, heart rate and sublingual temperature were measured and blood samples were withdrawn before exercise, immediately after and after a 30 min period of rest. Catecholamines were analyzed by radioenzymatic method and plasma renin activity (PRA) using commercial kits. Systolic blood pressure and heart rate after swimming were increased comparably in the two groups, diastolic pressure was unchanged in the controls and decreased in the wrestlers. Plasma cortisol remained unchanged. Plasma glucose tended to increase in the controls and so decrease in wrestlers, with a significant difference between them after swimming ($p<0.05$). However, plasma adrenaline was concomitantly increased in both groups ($p<0.01$). Noradrenaline and PRA were increased after swimming in both the control and trained group. The increments of noradrenaline and PRA in wrestlers were significantly reduced compared to the control group ($p<0.01$, $p<0.05$, respectively). Higher physical fitness in athletes significantly reduced plasma noradrenaline and angiotensin responses to maximal exercise demanding special skill in work performance which had not been included in their training program. Training of wrestlers did not cause an exaggerated plasma adrenaline response to exercise.

Key words
Wrestlers – Swimming – Adrenaline – Noradrenaline – PRA

Introduction

Neuroendocrine and cardiovascular responses to exercise depend on several factors, with physical fitness and skill in specific work performance playing an important role. Exercise training leads to a resetting of the central autonomic nervous system, modifies neuroendocrine functions and consistently results in upgraded efficiency of physiological regulations (Gilbert 1995). Trained sportsmen exhibit a reduced exercise response to an absolute work load on a bicycle ergometer in comparison to sedentary subjects, even when cycling had not been included in their training program (Galbo 1983). Jost *et al.* (1989) studied sympathoadrenergic regulation at rest in swimmers, long-distance runners, weight lifters, wrestlers and

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untrained men. They found that different types of physical training caused different adaptation of the autonomic nervous system. Therefore, the contribution of physical fitness to the adjustment of neuroendocrine responses to exercise is not clear when work performance demands skills in more complex coordinated movements for which athletes had not been trained before.

Two mechanisms have been reported to take part in exercise-induced activation of the endocrine system. At the onset of exercise, impulses from motor centres in the brain (central command, feed-forward component) activate neuroendocrine centres and elicit a work-dependent increase of sympathoadrenal activity and release of some pituitary hormones. If exercise is continued, the hormonal changes may be gradually intensified by signals generated in receptors sensing changes in the internal milieu (feedback component), such as lack of energy sources, hyperthermia, etc. (Galbo 1986, Kjaer *et al.* 1987, 1989). Neuroendocrine activation during exercise is supposed to increase mobilization of energy sources and to adjust the cardiovascular system to meet the elevated demands of working muscles for supplies of oxygen and nutrients. The sympathoadrenal and renin-angiotensin systems played an important role in the regulation of cardiovascular function during exercise. The responses of both systems depend on the intensity of exercise (Galbo 1986, Green *et al.* 1991, Fallo 1993). The release of catecholamines is mediated predominantly by central mechanisms from brain motor centres (Kjaer *et al.* 1987). Angiotensin is stimulated centrally *via* catecholamines and also from the periphery by changed blood supply in the kidneys. During prolonged exercise the importance of peripheral stimulation of the neuroendocrine system is enhanced.

The aim of our investigation was to clarify the role of physical fitness in sympathoadrenal and renin-angiotensin responses to maximal work performance, which requires higher movement coordination.

Subjects and Methods

Subjects

Ten highly trained young wrestlers (height 176±2 cm, weight 72±3 kg, age 19±0.6) of national rank were tested during their preparation for the competition season. They performed general fitness training and specific technique training twice a day. A group of nine healthy untrained males (height 181±3 cm, weight 76±3 kg, age 21±0.8) served as controls.

The investigation was approved by the Ethical Committee of the Institute of Experimental Endocrinology, Slovak Academy of Sciences. Written informed consent was obtained from all subjects before the study.

Design of the study

Volunteers fasting overnight arrived in the morning at 08:00 h. After 30 min rest in a comfortable sitting position, blood pressure, heart rate and sublingual temperature were measured and a blood sample was withdrawn for determination of pre-exercise values of hormones. The subjects then entered the pool with water of 29 °C. They swam for 24 min free style at a self-selected comfortable pace, followed by 3 min freestyle at maximal speed under verbal encouragement by the trainer. The subjects remained sitting in the pool, blood sample were immediately withdrawn, and other measurements were performed. Then the subjects left the pool and rested for 30 min in a horizontal position, covered with a blanket, and finally the last measurements were taken and blood samples were withdrawn.

Table 1. Heart rate, blood pressure (BP), body temperature and plasma cortisol concentrations before (−30 min), immediately after swimming (0 min), and after the rest (+30 min) in 9 control subjects and 10 wrestlers.

Groups	Controls			Wrestlers		
	−30	0	+30	−30	0	+30
Heart rate (bpm)	65±4	167±6**	81±4	61±2	168±4**	78±5
Systolic BP (mm Hg)	110±2	152±4**	108±3	111±3	151±6**	111±3
Diastolic BP (mm Hg)	76±3	74±5	75±3	76±2	51±4**++	75±3
Temperature (°C)	36.6±0.1	37.1±0.1	36.8±0.1	36.2±0.1	37.0±0.1	36.5±0.1
Cortisol Đμg/100 ml)	13.1±1.6	16.8±1.8	13.9±1.7	13.6±1.2	13.4±1.1	10.7±1.0

*Data are mean±S.E.M. Statistical significance against value at −30 min is indicated by asterisks (**$p<0.01$), between the groups by crosses (++ $p<0.01$).*

Analyses

Blood samples cooled on ice were centrifuged and plasma aliquots were frozen until assayed. All samples were run in the same assay. Plasma renin activity (PRA) was determined by kits of Immunochem, Prague, adrenaline and noradrenaline by the radioenzymatic method (Peuler and Johnson 1977), cortisol by radioimmunoanalysis (Ježová *et al.* 1994) and glucose by the glucose-oxidase method (Boehringer). Analysis of variance followed by paired comparisons according to Dunnet or Dunn, as appropriate, was used for the evaluation of the measured responses.

Results

Pre-exercise heart rate and systolic blood pressure and their augmentation after swimming were the same in wrestlers and control subjects and their increases were significant ($p<0.01$). Diastolic blood pressure remained constant after swimming in control subjects, while it showed a significant decrease ($p<0.01$) in wrestlers. Post-exercise body temperature showed a slight increase in both groups (up to 37 °C), which was significant in wrestlers ($p<0.01$). Plasma cortisol remained unchanged during the investigation. (Table 1).

The swimming-induced increase of plasma adrenaline, noradrenaline and PRA after exercise was significant in both groups ($p<0.01$). Noradrenaline and PRA responses, however, were significantly reduced in the trained vs. control group ($p<0.01$ and $p<0.05$, respectively). Plasma glucose was only slightly elevated in the control subjects and decreased in wrestlers, with a significant difference between the groups immediately after swimming ($p<0.05$) (Fig. 1).

After a 30-min rest, all the parameters measured returned to initial values both in trained and untrained subjects.

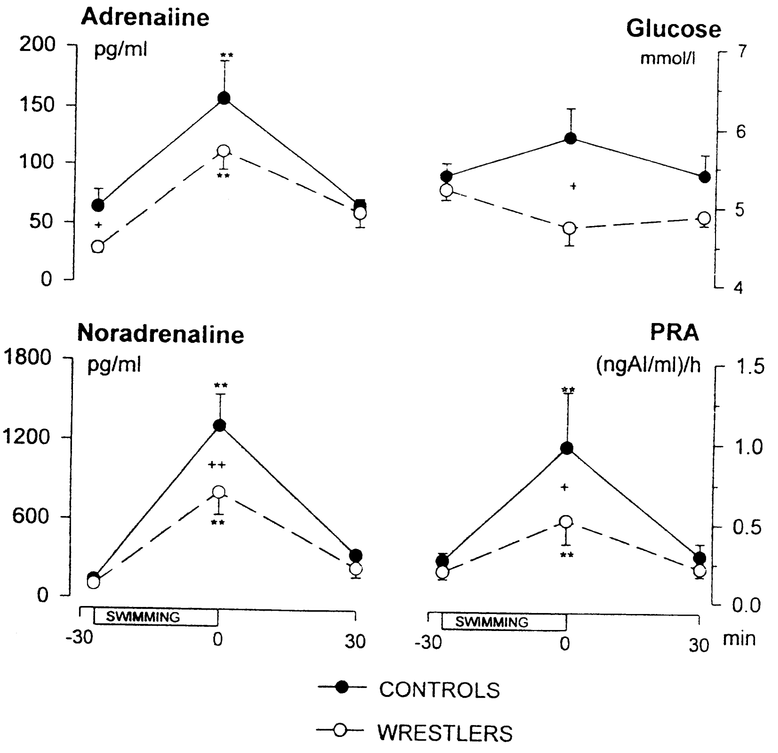

Fig. 1. *Means and S.E.M. of plasma adrenaline, noradrenaline, glucose and PRA in 10 wrestlers and 9 control subjects before (–30 min), immediately after swimming (0 min) and after 30-min rest. Statistical significance against –30 min are denoted by asterisks* ($^{**}p<0.01$)*, between the groups by crosses* ($^{+}p<0.05$, $^{++}p<0.01$)*.*

Discussion

In the present study, the neuroendocrine response of sedentary subjects was compared with professional national rank athletes whose physical fitness was assumed to be high (no direct measurements of VO_2 were performed). Short maximal swimming elevated the heart rate and systolic blood pressure identically in the two groups. Similar results were obtained by Jost *et al.* (1989). Maximal O_2 consumption in wrestlers was less than 5 % higher in comparison to untrained subjects, while the value of long-distance runners, building up endurance, was higher by 40 % than in the control group. The maximal ergometric performance in wrestlers was also the same as in untrained subjects. In the present study, training of wrestlers during the preparation period for the competitive season consisted of dynamic power training, technique training and general fitness training in which swimming was not included. In a previous study, we determined the relationship between neuroendocrine responses and either exercise intensity, or its duration and the total work output (Tatár *et al.* 1984). Our results showed that during relatively short physical exercise (4.5 min), the concentration of plasma adrenaline and noradrenaline was much more affected by the intensity of exercise than by its duration or total work output. The skill of wrestlers for swimming was similar to that in non-trained subjects and evaluation of the distance covered by swimming was greatly variable and did not support the better performance. Cardiovascular responses were of a similar submaximal intensity of exercise which allowed to compare the neuroendocrine responses in the two groups. Moreover, an exhausting work load in a water milieu may be an "unknown stimulus" for wrestlers from the point of view of their previous training. Exercise in water differs from the training of wrestlers because of the predominating work of arms, water pressure, horizontal position and different heat dissipation. During exercise, sympathetic nervous activation and PRA are higher if receptors sensing heat or cold are stimulated (Galbo 1986). The water temperature of 29 °C was below the thermoneutral level (33–34 °C for resting subjects) (Craig and Dvorak 1966). However, the slightly elevated body temperature in the present study indicated that heat production by working muscles was greater than heat dissipation, in spite of the high thermoconductance in the water environment.

Studies in man have shown that plasma noradrenaline can be considered as an index of sympathetic nervous activity and that plasma adrenaline represents a sympathoadrenal response (Christensen 1980). Increased activity of catecholamines has also an important role in activation of the renin-angiotensin system by directly affecting the redistribution of renal blood flow and by enhancing tubular sodium reabsorption. Vigorous training was found to reduce significantly the catecholamine and PRA responses to a given work load (Gharib *et al.* 1981, Green *et al.* 1991). However, different types of physical training caused various adaptations of the basal activity of the autonomic nervous system (Jost *et al.* 1989). Kjaer and Galbo (1988) found that, during exhausting submaximal exercise as well as supramaximal exercise carried out for fixed periods of time, endurance-trained athletes have higher plasma adrenaline concentrations than sedentary subjects, despite identical noradrenaline levels and heart rates in the two groups. Kjaer *et al.* (1984) also found an exaggerated response of adrenaline and noradrenaline release to an unknown stimulus (insulin-induced hypoglycaemia) in sportsmen with endurance training vs. untrained subjects. Similarly, rats exposed to repeated intense stress developed hypertrophy of the adrenal medulla and augmented plasma adrenaline and noradrenaline concentrations to an unknown stress stimulus (Kvetňanský *et al.* 1984).

In our study, post-exercise elevations of plasma adrenaline did not differ in the two groups. The sensitivity of adrenaline release to even mild hypoglycaemia was exaggerated during exercise (Galbo 1986). The glucose concentration in wrestlers after swimming was lower than in untrained men, however, the plasma adrenaline response ran in parallel in trained and untrained subjects. This indicated that intensive training of wrestlers did not result in "sport adrenal medulla" (Galbo *et al.* 1986) with enhanced release of catecholamines, a phenomenon observed in athletes after endurance training. On the other hand, the increments of plasma noradrenaline and PRA after swimming were significantly lower in wrestlers than in untrained subjects. This reduction of noradrenaline and PRA responses of athletes showed an advantage of higher physical fitness even in non-adequate work performance demanding specific skills. The mechanism of the different responses of adrenaline and noradrenaline to a given work load is not clear and is apparently affected by the specific training of wrestlers.

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