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Relation between Changes in Serum Hypoxanthine Levels by Exercise and Daily Physical Activity in the Elderly

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Saiki, S., Sato, T., Hiwatari, M., Harada, T., Oouchi, M. and Kamimoto, M. *Relation between Changes in Serum Hypoxanthine Levels by Exercise and Daily Physical Activity in the Elderly.* Tohoku J. Exp. Med., 1999, **188** (1), 71-74 —— Effect of exercise at mild intensity on the serum levels of hypoxanthine was studied in eleven healthy elderly subjects. They were divided into the active and sedentary groups according to their daily physical activity. They performed exercise testing to walk for 5 minutes keeping heart rate at approximately 70% of the maximum heart rate. Mean intensity of exercise estimated according to Karvonen's formula in the active or sedentary group was $41.8 \pm 9.6\%$ or $34.1 \pm 6.1\%$, respectively. In the sedentary group, the serum hypoxanthine levels at 10 minutes after completion of walk load was significantly higher than that before exercise. Changes in the serum hypoxanthine levels in the active and sedentary groups were -0.97 ± 1.36 and 0.80 ± 0.57 μmol/liter, respectively ($p < 0.05$). This result suggests that mild intensity exercise increases the serum hypoxanthine concentration in the elderly leading inactive daily life, and physical activity suppresses an increase in the serum hypoxanthine levels by mild exercise. ——— hypoxanthine; exercise; physical activity

Consumption of muscle adenosine triphosphate (ATP) is pronounced by intense exercise, followed by formation of hypoxanthine, which diffuses slowly from muscles to blood stream, and the serum level of hypoxanthine is thought to be an extracellular metabolite monitoring the intracellular energy metabolism (Murray 1971). There are great individual variations of changes in plasma concentrations of hypoxanthine by exercise at intensity exceeding anaerobic threshold (Ketai et al. 1987; Bangsbo et al. 1992; Hellsten-Westing et al. 1993b). In our previous study (Saiki et al. 1999), the serum levels of hypoxanthine were increased by exercise at mild as well as moderate to submaximal intensity. There are several reports suggesting that training improves energy metabolism in the

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muscle, and causes a decrease in resting levels of muscle adenine nucleotides and in plasma hypoxanthine levels by intense exercise (Hellsten-Westing 1993a, b; Stathis 1994). The aim of this study is to investigate changes in serum levels of hypoxanthine by mild exercise in the elderly, and effect of daily physical activity on them.

Eleven elderly subjects with mean age of 75±5 years participated in this study after informed consent. They were healthy without significant diseases and their routine blood chemistry examinations were normal. They were divided into the active and sedentary groups according to their daily physical activity; subjects in the active group still had a job, and were doing regular physical exercise and working in the farm, and subjects in the sedentary group were retired and had no habits to do physical exercise or work. Their total body fat was estimated by measurement of skinfold thickness at the triceps and subscapula. The lean body mass was calculated by subtracting the body fat mass from their weight. The active group showed tendency to have higher body mass index, higher lean body mass, and lower body fat (Table 1). They walked for 5 minutes around square of 25 m length. Their heart rate was monitored by heart rate monitor (DS-1033B, Fukuda Co., Tokyo), and it was maintained at 70 % of the maximum. Intensity of exercise was estimated by heart rate response as reported previously (Saiki et al. 1999). Venous blood samples were drawn from the anticubital vein prior to and at 10 minutes after the completion of the walk load. Serum hypoxanthine was analyzed with high-performance liquid chromatography, as previously reported (Saiki et al. 1999). Statistical analyses were performed using the Stat View, version J4.02 software program (Abacus Concepts Inc., Berkeley, CA, USA) and Student's t-test, and $p<0.05$ was considered significant. Values were given in terms of mean±S.D.

Intensity of exercise calculated as a ratio to the maximum heart rate was 70.0±3.4% in the active group and 67.2±2.4% in the sedentary group. Intensity calculated by Karvonen's formula was 41.8±9.6 and 34.3±6.1%, and walk distance was 342±51 and 368±43 m, respectively. There was no significant difference in intensity of walk load or walk distance (Table 1). The serum levels of hypoxanthine before exercise in the active and sedentary groups were 3.81±2.92 and 2.10±1.48 μmol/liter, respectively. There was statistically significant difference between the serum hypoxanthine levels before exercise and 10 minutes after completion of walk load in the sedentary group (Table 2). Changes in the serum hypoxanthine levels at 10 minutes after completion of walk load in these groups were −0.97±1.36 and 0.80±0.57 μmol/liter, respectively, and there was statistically significant difference between them (Table 2). There was no relation between changes in plasma hypoxanthine levels and intensity of exercise loaded in this study. Ketai et al. (1987) reported that elevation of the plasma hypoxanthine levels occurs during exercise at intensity that exceeds the ventilatory threshold. McCully et al. (1988) demonstrated that muscle contents of ATP were

TABLE 1. *Characteristics of the subjects, exercise intensity and walk distance*

	Active group	Sedentary group
Number	5	6
Gender	F1, M4	F2, M4
Age (year)	75±6	76±4
BMI (Kg/cm²)	26.3±1.8	24.3±2.2
Body fat (%)	16.8±5.2	20.2±5.3
Lean body mass (Kg)	51.1±4.4	47.2±5.4
Heart rate before exercise	71±9	71±6
Heart rate after exercise	101±6	97±6
ΔHeart rate	30±7	26±8
Intensity (%)[a]	70.0±3.4	67.2±2.4
Intensity (%)[b]	41.8±9.6	34.3±6.1
Walk distance (m)	342±51	368±43

Values are mean±S.D.
[a] calculated as a ratio to the maximum heart rate.
[b] calculated according to Karvonen's formula.

TABLE 2. *Comparison of changes in serum concentration of hypoxanthine by a walk load between the active and sedentary groups*

	Serum hypoxanthine concentration (μmol/l)		
	Before load	After load	Difference
Active group	3.81±2.92	2.84±1.73	−0.9±1.36
Sedentary group	2.10±1.48	2.90±1.88[a]	0.80±0.57[b]

Values are mean±S.D.
[a] $p<0.05$ Before load vs. 10 minutes after load.
[b] $p<0.05$ Active group vs. Sedentary group.

decreased even by mild exercise. Our previous study (Saiki et al. 1999) demonstrated significant increase in the serum hypoxanthine concentration at 10 minutes after the walk load even at mild intensity. In this study, serum levels of hypoxanthine also increased significantly in the sedentary elderly peoples after walk load at mild intensity, which was calculated by Karvonen's formula as reported in our previous study.

According to Stathis et al. (1994), muscle hypoxanthine is increased extensively after intense exercise and its increase is lower in the trained subjects. According to Hellsten-Westing et al. (1993a), the activity of AMP deaminase was lower and the activities of hypoxanthine phosphoribosyl transferase and phosphofructokinase were significantly higher compared with pretraining levels.

In this study, lean body mass showed tendency to be higher and body fat to be lower in the active group comparing with the sedentary group who were retired and not doing farm work or sport. Physical training are usually accompanied by a heart rate reduction during submaximal exercise. In this study, same level of heart rate was maintained during exercise in the both groups, and it can be speculated that actual intensity of exercise in the sedentary group did not exceed that in the active group. Though they walked almost same distance in the exercise test, increase in the serum levels of hypoxanthine was greater in the sedentary group comparing with the active group. These results suggest that daily physical activity suppresses the increase in the serum levels of hypoxanthine by mild exercise. Above mentioned mechanism to reduce degradation of adenine nucleotides may contribute to lower hypoxanthine release from muscles by mild exercise in the active elderly group. Such a reduction may be also achieved through an enhanced capacity of muscles to regenerate ATP via carbohydrate and lipid metabolism.

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