

Effect of Somatotype on the VO_2 max and Hormone during Treadmill Walking

The purpose of this study was to investigate the effect of somatotype on the VO_2 max and hormone (adrenaline and noradrenaline) during treadmill walking. Forty healthy men participated and were randomized to four groups: Male 1 (M1) group, Male 2 (M2) group, Male 3 (M3) group, and Male 4 (M4) group. M4 group is the largest body type, and M1 group is the smaller the body type. Participants walked at a speed of 3.5 km/h for five minutes at an incline angle of 0°, 5°, and 10° in the treadmill. Maximum oxygen consumption and hormone (adrenaline and noradrenaline) were measured. In the results, VO_2 max has significantly increased according to the degree of the treadmill inclination, and M4 group (larger body type) consumed more oxygen than the M1 group (smaller body type). In the hormone, there was a significant increase in adrenaline concentration after walking in all groups, and there was a significant difference in M1–M4, M2–M4 and M3–M4. The noradrenaline concentration significantly increased after treadmill gait in all groups, and there was no significant difference in noradrenaline between groups. This study suggests that the larger body type consumes more oxygen during walking, and treadmill walking contributes to an increase in the concentration of adrenaline and noradrenaline.

Key words: *Somatotype; VO_2 max; Adrenaline; Noradrenaline*

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INTRODUCTION

The somatotype (body type or body shape) is an easy and concise tool to describe the human body's appearance¹⁾. This is a well-established tool for studying temporal and spatial variations^{1, 2)}. The studies of somatotype are used in many areas including posture alignment and posture stability, risk factors for disease, and athletic programs³⁾.

In extreme exercise, the maximal oxygen uptake of ectomorph is lower than that of endomorph and mesomorph, and the respiratory exchange rate, plasma lactate, and oxygen ventilation are high⁴⁾. The maximum oxygen uptake is related to the end-diastolic volume, left ventricular end-diastolic diameter, left ventricular mass, and aerobic capacity can be predicted by heart size, functional ability, and human body measurements⁵⁾.

Exercise time, exercise intensity, and exercise status changed the concentration of catecholamine, cortisol, and growth hormone, and the increase in treadmill

walking speed did not significantly change catecholamines⁶⁾. Catecholamines are classified as adrenaline and noradrenaline, and they act as metabolic and physiological regulators of exercise as an activity indicator of sympathetic neuralgia⁷⁾. During exercise at high temperatures, blood levels of adrenaline and noradrenaline are higher⁷⁾. The concentration of adrenaline and noradrenaline is increased by exercise time, muscle strength, and high fever. It also reflects the activities and physiological stresses of the sympathetic nervous system⁸⁾. Men and women with coronary artery disease have significantly increased levels of noradrenaline and adrenaline during walking⁹⁾. Besides, in treadmill exercise, catecholamine increased in proportion to exercise intensity, which is highly correlated with the exercise intensity expressed as % maximal oxygen uptake than maximum oxygen uptake (l/min, ml/kg/min)¹⁰⁾. Therefore, this study examined the effect of somatotype (body type), and treadmill angle on the VO_2 max and concentration of hormones (adrenaline and noradrenaline).

SUBJECTS AND METHODS

Subjects

Forty male healthy male students participated in this study. The subjects were divided into four groups: M1, M2, M3, and M4. In the overall body type, M1 is the smallest and M4 is the largest. Each group was assigned ten subjects, and the classification of body type adopts the method of previous research¹⁰⁾ (Table 1). In this study, subjects with height less than 163cm were excluded. In the body type category, 10 subjects were selected to satisfy all three conditions by measuring height, chest girth, and waist girth (Table 2).

The subjects were to gait for five minutes each at a degree of the treadmill of 0°, 5°, and 10°. The subjects agreed to participate in the study after receiving explanations regarding the purpose and procedures of the experiment. The subjects signed an informed consent statement before participation.

Procedure

The subjects rested for an hour before the walking. And then, the subjects walked at a speed of 3.5 km/h for five minutes at an incline angle of 0°, 5°, and 10°

in the treadmill. There was the 30 minutes rest between each stage. In the first phase, the treadmill incline was forced to walk at 0° for 5 minutes, after the 30 minutes rest, and then at 5° to the treadmill incline. The 30 minutes later, the treadmill incline was forced to walk at 10° for 5 minutes.

Measurement of the maximum oxygen uptake

The zero points of the machine were adjusted using a gas containing 5% carbon dioxide and 16% oxygen before analyzing the respiratory gas. Respiratory gas was analyzed in real time by wearing a mask while walking on a treadmill. The maximum oxygen uptake (VO_2 ; ℓ / m) was analyzed by filtering every 1 minute.

Measurement of adrenaline and noradrenaline

Blood samples were collected before and after treadmill gait, and the concentrations of adrenaline and noradrenaline were measured using a 1340 electrochemical detector (Bio-Red company). Standardization was performed before analysis using Dhydroxybenzylamine (Sigma company). Immediately after 10 minutes of shaking, 100 μl of 0.1 N was extracted and the conductivity was measured 1.1 $\mu\text{l} / \text{min}$ on 200 psi at 0.65 V. The room temperature was maintained at 24°C–25°C.

Table 1. General characteristic of subjects

Group	Age (years)	Weight (kg)	Height (cm)	BMI((kg/m ²)
M1	22.60±2.91	68.23±4.52	166±0.17	24.76±1.81
M2	22.30±2.87	68.89±7.58	170±0.08	23.77±2.69
M3	23.80±2.25	79.89±1.49	176±0.13	24.56±3.45
M4	23.90±2.42	81.70±9.32	180±0.11	26.30±2.80

Mean±Standard deviation

M1~M4 : In the overall body type, M1 is the smallest and M4 is the largest

Table 2. Criteria of somatotype classification

Group	Height (cm)	Chest girth (cm)	Waist girth (cm)
M1	163.0–167.0	83.0–104.0	68.0–89.0
M2	168.0–172.0	83.6–107.0	68.6–92.0
M3	173.0–177.0	84.0–110.0	69.0–95.0
M4	178.0–182.0	86.6–111.0	71.0–86.0

Mean±Standard deviation

M1~M4 : In the overall body type, M1 is the smallest and M4 is the largest

Statistical analysis

For data processing, SPSS 18.0 version was used. Descriptive statistics were processed using the general characteristics of subjects. One-way ANOVA was used to identify the change between the groups. The paired T-test was used to identify before and after in the groups. The significance level was set at p < .05.

RESULTS

As a result, VO₂max has significantly increased according to the degree of the treadmill inclination (p < .05).

The M1, M2, M3, and M4 all groups showed differences within the group (Table 3). In the between the group, M1-M4 groups and M2-M4 showed significant differences at the 0° and 10° grade. At 5°, there was a significant difference in groups between M2-M4 (p < .05).

In the hormone, there was a significant increase in adrenaline concentration after walking in all groups, and there was a significant difference in M1-M4, M2-M4 and M2-M4 (p < .05). The noradrenaline concentration significantly increased after treadmill gait in all groups (p < .05), and there was no significant difference in noradrenaline between groups (Table 4).

Table 3. Comparison of VO₂max between the groups

(ml/kg/min)

	S ₀ (0°)	S ₅ (5°)	S ₁₀ (10°)
M1	622.9±119.9	890.0±164.6*	1163.5±205.7 † ‡
M2	661.5±122.2	878.7±113.7*	1166.5±99.2 † ‡
M3	817.5±109.0	1000.0±177.1*	1312.0±218.3 † ‡
M4	706.9±136.0* † †	1071.4±120.8* † †	1404.8±169.0* † † † †

Mean±Standard deviation

M1~M4 : In the overall body type, M1 is the smallest and M4 is the largest

S₀, VO₂max at five minutes (0° walking for five minutes); S₅, VO₂max at five minutes (5° walking for five minutes); S₁₀, VO₂max at five minutes (10° walking for five minutes)

*, significant difference between S₀ and S₅; †, significant difference between S₀ and S₁₀; ‡, significant difference between S₅ and S₁₀; §, significant difference between M1 and M2; ††, significant difference between M1 and M3; †‡, significant difference between M1 and M4; **, significant difference between M2 and M3; †††, significant difference between M2 and M4; ‡‡, significant difference between M3 and M4

Table 4. Comparison of adrenalin and noradrenalin

(pg/ml)

	Adrenalin		Noradrenalin	
	Pre	Post	Pre	Post
M1	5.89±0.92	11.46±1.15* †	43.22±4.42	58.39±4.10*
M2	5.81±1.00	11.23±0.74* †	41.41±3.77	60.65±6.63*
M3	5.45±1.13	11.55±1.03*§	39.66±3.92	62.50±5.17*
M4	5.89±1.03	15.70±2.29*	40.41±4.11	64.52±8.39*
P		0.00		0.18

Mean±Standard deviation

M1~M4 : In the overall body type, M1 is the smallest and M4 is the largest

p show that the significant difference between the groups at evaluation p < .05.

*, p < .05 change within the group; †, Significant difference between M1 and M4; ‡, Significant difference between M2 and M4; §, Significant difference between M3 and M4 (p < .05)

DISCUSSION

This study was to investigate the effect of somatotype on the VO_2 max and hormone (adrenaline and noradrenaline) during treadmill walking in 20's man. VO_2 max of all groups increased significantly after treadmill gait. In comparison between groups, M1–M4 groups and M2–M4 showed significant differences at the 0° and 10° degree. At 5°, there was a significant difference in groups between M2–M4. Also, it was found that the larger the body type, the more the maximum oxygen uptake. Bolonchuk et al. (2000) reported that the ectomorph type (skinny type) is the lowest intake VO_2 max compared to mesomorph type (normal type) or endomorph type (fat type)⁴⁾. These results are consistent with the results of this study. Jürimäe et al. (1998) reported that overweight women had higher levels of aerobic fitness (VO_2 max/kg) than women who did not¹²⁾. Our findings are similar to many other studies in which large bodies consume more oxygen. Finally, the body size and treadmill walking angle were proportional to the maximal oxygen uptake.

There was a significant increase in adrenaline concentration after walking in all groups, and there was a significant difference in M1–M4, M2–M4 and M3–M4. The noradrenaline concentration significantly increased after treadmill gait in all groups, and there was no significant difference in noradrenaline between all groups. This result is similar to the study by Guezennec et al. (1986) that increases the levels of noradrenaline and adrenaline after low-intensity exercise and is similar to the study by Sothmann et al. (1987) that exercise intensity is proportional to the concentration of noradrenaline^{13, 14)}. A study of exponentially increasing noradrenaline and adrenaline by stimulating the peripheral nervous system during an incremental exercise test supported our findings that treadmill gait with increasing tilt over time promoted the secretion of noradrenaline and adrenaline¹⁵⁾.

Adrenalin promotes the transfer of substrates to muscles by controlling blood volume and cardiac output¹⁶⁾. Therefore, treadmill gait promoted adrenaline hormone secretion, and subsequently, it was thought to have influenced increase of maximal oxygen uptake by promoting blood movement. The physical activity called treadmill walking activates the sympathetic nervous system, which increases adrenaline and noradrenaline. This hormone secretion increases cardiac output for increased intramuscular blood flow, promotes heart rate, and promotes circulation by expanding the blood vessels of the heart or muscle¹⁷⁾. These effects may have influenced the increase in

maximal oxygen uptake, which is a dependent variable in this study.

The limitations of this study are that the maximum oxygen uptake and hormone levels were measured only in the male in their twenties. Therefore, future studies should be conducted on men and women of various ages.

CONCLUSION

This study investigate the effect of somatotype on the VO_2 max and hormone (adrenaline and noradrenaline) during treadmill walking in 20's man. VO_2 max in the degree of the treadmill has significantly increased and all groups showed differences within the group. In the hormone, there was a significant increase in adrenaline concentration after walking in all groups, and there was a significant difference in the between groups. As the results, the larger the somatotype, the higher the intake of oxygen and the secretion of hormone. The findings of this study suggest that the larger body type consumes more oxygen during walking, and treadmill walking contributes to an increase in the concentration of adrenaline and noradrenaline.

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