The Ventilatory Anaerobic Threshold with Reference to Physical Characteristics, Habitual Exercise, and Regional Differences

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Anaerobic threshold (AT), defined as "the level of $\dot{V}O_2$ or work rate just below that at which metabolic acidosis and the associated changes in gas exchange parameters occur" (Wasserman et al., 1973), is now widely used in the field with regard to physical work capacity. AT detected by blood lactate is called "lactate threshold", and by some criteria of gas exchange variables is called "ventilatory anaerobic threshold (VAT)" or "ventilatory threshold" during a progressive incremental-load exercise. This report attempts to study the effects of some factors which included the regional difference to VAT. We, therefore, evaluated VAT, physical characteristics, and the history of habitual exercise and locality of residence in 14 young males who are now a comparative uniform population as to the living status and age.

Methods

Fourteen male Japanese, aged 19. 3-22. 9 yrs, volunteered to participate in this experiment. They were members of the tennis club in School of Dentistry, Hiroshima University. Subject performed an incremental-load ergometer test in which the initial work rate was the 2

minutes unloaded cycling and thereafter its rate was increased 150 kgm every 1 minute until exhaustion. Gas exchange parameters and ECG were monitored continuously (aerobics processor 391; SANEI Inc.). To detect VAT by non-linear increase in $\dot{V}E$, we employed the segmented regression analysis (Fukuba et al., 1984) to $\dot{V}E$ data excluding over 75% of $\dot{V}O_{2max}$, then estimated VAT. $\dot{V}O_{2max}$ per weight ($\dot{V}O_{2max}$/wt) was measured at the same ergometer test as the physical fitness level in the present. Skinfold thickness was measured on the site of triceps and subscapular using a caliper, and %fat was estimated by standard formulae (Brozek et al., 1963; Nagamine & Suzuki, 1964). Habitual exercise and locality of residence were taken from the questionnaire. Subject was asked to report his history of exercise during junior high and high school, and place and duration of his residence. The relationship between VAT (expressed as $\dot{V}O_2$ or $\%\dot{V}O_{2max}$) and some factors was examined by multiple regression analysis with VAT as the dependent variable.

Results and Discussion

As sujects in this report have similar living status, physical conditioning, and age (mean=20.9, SD=1.0 yrs), they can be regarded as a comparative uniform population in relation to background factors. This is important to research the comparison of presonal history.

Mean values of VAT expressed as $\dot{V}O_2$, $\%\dot{V}O_{2max}$, HR, and $\%HR_{max}$ were 1110 ml/min, 35.6%, 107 beats/min, and 30.1%, respectively (Table 1). These values were somewhat lower than the previous studies, because our subjects do not probably taken in a strenuous endurance training. It is confirmed by the result that their values of $\dot{V}O_{2max}$/wt (mean=40.8, SD=4.1 ml/min·kg) are on an average level, or

Table 1. Physical and physiolosical characteristics, and history of habitual exercise and residence in subjects.

No. of Subjects	physical characteristics				vantilatory AT				Locality of Residence in the past**	
	age (yrs)	ht (m)	wt (kg)	%fat	$\dot{V}O_2$ (ml/min)	$\%\dot{V}O_{2max}$	$\dot{V}O_{2max}$/wt (ml/min kg)	Habitual Exercise*		
1.	22.9	1.70	61.0	12.8	1087	40	39.1	0	1	
2.	22.1	1.63	61.0	14.4	1047	36	41.3	0	1	
3.	20.5	1.68	61.5	10.4	1317	41	44.9	1	0	Tottori (20)
4.	20.5	1.75	59.0	8.3	793	22	42.3	1	1	
5.	19.7	1.71	64.5	10.7	1140	35	43.2	1	1	
6.	19.3	1.80	72.5	12.9	1249	36	40.9	1	0	Osaka (18)
7.	19.8	1.74	56.0	10.2	1067	40	41.3	1	0	Hyogo (15) Okayama (3)
8.	21.3	1.72	64.5	11.1	997	30	40.3	1	0	Osaka (18)
9.	21.7	1.74	83.0	16.6	1347	38	36.0	1	1	
10.	21.1	1.69	59.5	8.7	1639	53	49.1	1	0	Shizuoka (18)
11.	21.3	1.65	63.0	12.6	890	29	36.2	0	0	Osaka (18)
12.	21.2	1.76	65.0	14.0	1145	39	38.9	1	0	Yamaguchi (7) Osaka (12)
13.	20.1	1.70	65.0	11.9	725	23	33.6	0	1	
14.	21.1	1.72	56.0	8.7	1103	37	44.3	0	0	Shiga (8) Aichi (2)

* ; 1-took a moderate exercise regularly during junior and high school, 0-did not
** ; 1-Hiroshima Prefecture only, 0-others (years of residence)

rather a low one compared to the same age. Body mass index (BMI) and %fat one calculated as index of physical factors. These indices showed none of obesity among our subjects. Personal habitual exercises during adolescence are various, so we evaluated from the questionnaire only whether he took part in the sports club or not. As to a personal history of residence, eight of them changed the place of living once or twice. So we roughly evaluated whether he had lived in Hiroshima Prefecture from birth or not.

Multiple regression analysis was applied to examine the relationship between VAT and regional differences using VAT (expressed as $\dot{V}O_2$ or $\%\dot{V}O_{2max}$) as dependent variable, regional differences as independent variable, and $\dot{V}O_{2max}$/wt, BMI or %fat, and habitual exercise as the covariables. This analysis revealed that the only factor significantly related to VAT was $\dot{V}O_{2max}$/wt. These four independent variables accouted for 54–76% of the total variation in VAT. The regional differences had no significant conrtibution. Habitual exercise and physical factors had no apparent relation to VAT either. Generally, the high correlation of AT to $\dot{V}O_{2max}$ or performance is recognized. In this report, however, $\dot{V}O_{2max}$/wt contributes significantly about only 37%. AT is considered as the integrated index of the oxydative capacity in working muscle and the lactate utilization capacity to avoid the lactate accumulation. On the other, $\dot{V}O_{2max}$ is determinated mainly by cardio-respiratory O_2 transport capacity. Therefore, AT and $\dot{V}O_{2max}$ have a different aspect in the physiological mechanism.

It is concluded that regional differences and habitual exercise do not affect VAT, and the only variable, $\dot{V}O_{2max}$/wt significantly related to VAT does not account well.

References

1) Brozec, J., F. Grande, J. T. Anderson, and A. Keys: Densitometric analysis of body composition: review of some quantitative assumpions, Ann. N. Y. Acad. Sci., 110:113-140, 1963.

2) Fukuba, Y., S. Usui, H. Sasahara, and K. Kikuchi: Development of the method of determinating ventilatory anaerbic threshold, Jap. J. Physical Fitness Sports Med., 33(5):213-216, 1984.

3) Naganine, S. and S. Suzuki: Anthropometry and body composition of Japanese young men and women, Human Biol., 36:8-15, 1964.

4) Wasserman, K., B. J. Whipp, S. N. Koyal, and W. L. Beaver: Anaerobic threshold and respiratory gas exchange during exercise, J. Appl. Physiol., 35(2):236-243, 1973.