*Acta Medica Okayama*

*Volume* 49, *Issue* 2 1995 *Article* 7

APRIL 1995

# Training intensities for aerobic exercise determined on untrained healthy men.

Mochiyoshi Miura[*] Shigeki Kohda[†]
Yoshio Mino[‡] Hideyasu Aoyama[**]

[*]Joetsu University of Education,
[†]Kochi Medical School,
[‡]Okayama University,
[**]Okayama University,

# Training intensities for aerobic exercise determined on untrained healthy men.*

Mochiyoshi Miura, Shigeki Kohda, Yoshio Mino, and Hideyasu Aoyama

## Abstract

The purpose of this study was to determine the aerobic training intensity from the maximal and submaximal running exercise in 21 untrained adult men. To accomplish this, we evaluated the relationship between physiological (oxygen intake and heart rate) and physical parameters (running speed) of training intensity, and determined the training intensity at the submaximal exercise. Oxygen intake and heart rate were measured by a treadmill test. The maximal oxygen intake (VO2 max), and the aerobic threshold (AerT) and anaerobic threshold (AT) were measured to determine respiratory gas exchange. Running capacity was measured by a 12-min running and treadmill test. For the maximal exercise, there was a significant correlation ($r = 0.88$, $P < 0.01$) between VO2 max and 12-min running distance (speed). In addition, the oxygen intake and heart rate at AerT and AT in the submaximal exercise were linearly correlated with running speed. Three levels of training intensity at the submaximal exercise were termed: light, moderate, and heavy. Since AerT was the lower limit intensity and AT was the upper limit, we took the middle of their values as the moderate intensity. The end point for the determination of the training intensity at the submaximal exercise was estimated to be 85% VO2 max and 180 beats.min-1.

**KEYWORDS:** aerobic exercise, training intensity, aerobic threshold, anaerobic threshold, submaximal exercise

---

*PMID: 7618488 [PubMed - indexed for MEDLINE]

Acta Med Okayama 1995; 49(2): 107-112

# Training Intensities for Aerobic Exercise Determined on Untrained Healthy Men

Mochiyoshi Miura*, Shigeki Kohda[a], Yoshio Mino[b] and Hideyasu Aoyama[b]

Department of Health and Physical Education, Joetsu University of Education, Joetsu 943, [a]Department of Public Health, Kochi Medical School, Kochi 780 and [b]Department of Hygiene and Preventive Medicine, Okayama University Medical School, Okayama 700, Japan

The purpose of this study was to determine the aerobic training intensity from the maximal and submaximal running execise in 21 untrained adult men. To accomplish this, we evaluated the relationship between physiological (oxygen intake and heart rate) and physical parameters (running speed) of training intensity, and determined the training intensity at the submaximal exercise. Oxygen intake and heart rate were measured by a treadmill test. The maximal oxygen intake ($\dot{V}O_2$ max), and the aerobic threshold (AerT) and anaerobic threshold (AT) were measured to determine respiratory gas exchange. Running capacity was measured by a 12-min running and treadmill test. For the maximal exercise, there was a significant correlation ($r=0.88$, $P<0.01$) between $\dot{V}O_2$ max and 12-min running distance (speed). In addition, the oxygen intake and heart rate at AerT and AT in the submaximal exercise were linearly correlated with running speed. Three levels of training intensity at the submaximal exercise were termed: light, moderate, and heavy. Since AerT was the lower limit intensity and AT was the upper limit, we took the middle of their values as the moderate intensity. The end point for the determniation of the training intensity at the submaximal exercise was estimated to be 85 %$\dot{V}O_2$ max and 180 beats·min$^{-1}$.

**Key words:** aerobic exercise, training intensity, aerobic threshold, anaerobic threshold, submaximal exercise

Aerobic fitness is recognized as the most important factor in physical fitness (1). The use of aerobic training as a means of developing and maintaining a healthy cardiorespiratory system has become widespread. Aerobic exercise and fitness improve circulation, respiration, fat metabolism, body weight and fatigue, and reduce the risk of heart disease (2). Recently, aerobic exercise has also received considerable attention in the prevention and treatment of coronary heart disease (3-6).

To maximize the benefit of exercise and to minimize the associated risks, it is necessary to know the allowable exercise load for each individual. Among the basic components of exercise load (intensity, duration and frequency), intensity is recognized as the most important in terms of safety as well as effective training (7, 8). The intensity of exercise has generally been estimated by percent oxygen intake (% $\dot{V}O_2$ max) or percent heart rate (% HRmax) relative to their maximum values at the maximum effort (4, 9, 10-14). These values, however, indicate only physiological training intensity, and it is necessary to measure physical training intensity such as running speed during exercise. The running speed can be used as practical indices of training intensity.

Kindermann *et al.* (10) suggested that % $\dot{V}O_2$ max and % HRmax do not necessarily reflect the metabolic responses. It is, therefore, necessary to define the training intensity at submaximal exercise based on the aerobic energy metabolism. Since maximal effort exposes the subject to unnecessary health risks (4, 6, 12), maximum values have typically been estimated from those values obtained during submaximal exercise (3-5, 9). However, large errors occur by this method. Therefore, it is necessary to define the end point for the determination of training intensity during submaximal exercise.

Skinner and McLellan (11) reviewed studies on the transition from aerobic to anaerobic metabolism during exercise of progressively increasing intensity. They concluded that the application of the concepts of aerobic threshold (AerT) and anaerobic threshold (AT) to the refinement of training programs for athletes as well as the untrained person would be a logical and desirable out-

---

* To whom correspondence should be addressed.

come. However, there are no data concerning AerT and AT as training intensity for Japanese untrained men. The AerT and AT, which are used in this study, are based on energy metabolism and have been used as indices of the aerobic ability at submaximal exercise (4-6, 10-15).

The purpose of this study was to evaluate the relationship between physiological training intensity, as represented by oxygen intake and heart rate, and physical training intensity, as represented by running speed, which were measured during maximal and submaximal running exercise in 21 untrained adult men. We also compared the aerobic training intensity in relation to oxygen intake, heart rate and running speed using AerT and AT at submaximal exercise with a new protocol, and examined the end point for determination of the training intensity during submaximal exercise.

## Subjects and Methods

The subjects were 21 untrained (no regular sports activities) healthy male college students (mean age 20 ± 1 years) who volunteered for this study. Their mean height (171.5 ± 4.2cm) and weight (61.9 ± 5.8 kg) were similar to Japanese males of the same ages (16).

The maximum running tolerance was estimated from the mean running speed measured during a 12-min outdoor run. Oxygen intake at AerT and AT and maximal oxygen intake ($\dot{V}O_2max$) were measured on a progressive exercise test using a treadmill.

Fig 1 shows the protocol of the treadmill running. The test began with a 4-min warm-up period at a slow speed (120 $m \cdot min^{-1}$), and the workload was increased stepwise by 10 $m \cdot min^{-1}$ every minute until exhaustion. The gradient of the treadmill was increased to 3 % when the speed reached 220 $m \cdot min^{-1}$.

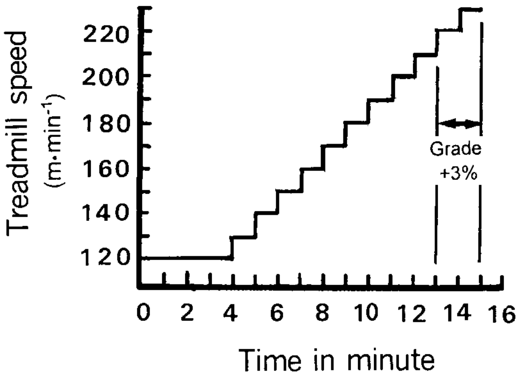

**Fig. 1** Protocol of treadmill running test.

The oxygen intake during exercise was measured every minute. The maximal oxygen intake was determined during a 1-min period after the heart rate of the subjects exceeded 180 $beats \cdot min^{-1}$ and the oxygen intake reached a plateau (1, 15). The heart rate during the exercise was recorded continuously throughout the experiment by electrocardiography.

The oxygen intake was measured using a computer-assisted on-line system (Nova 01, Nippon Data General Co., Tokyo, Japan) (17). Pulmonary ventilation was measured using a piston-type spirometer with a rotary-encoder which detects the displacement of the piston in proportion to volume changes. The electric pulses generated by the rotary-encoder were integrated with an electric impulse counter and input into the computer system.

The oxygen ($O_2$) and carbon dioxide ($CO_2$) concentrations of the expired air were determined with an oxygen gas analyzer (S-3A P. K. Morgan Co., Kent, Chatham, England) and an infrared $CO_2$ gas analyzer (Type B-E, Godart Statham B. V. Ltd. Bilthoven, Holland), respectively, using the computer system connected to an A-D converter. The computer calculated the mean values of the following parameters every 60 sec: expiratory minute volume ($\dot{V}E$), oxygen intake ($\dot{V}O_2$), carbon dioxide output ($\dot{V}CO_2$), expiratory oxygen concentration ($FEO_2$), expiratory carbon dioxide concentration ($FECO_2$), gas exchange ratio (R), ventilation equivalent for oxygen ($\dot{V}E/\dot{V}O_2$) and ventilation equivalent for carbon dioxide ($\dot{V}E/\dot{V}CO_2$).

The ventilatory thresholds (AerT and AT) were determined using expiratory gas exchange parameters during the incremental exercise test on the treadmill. AerT was estimated as the point at which the first nonlinear increase in $\dot{V}E$ and $\dot{V}CO_2$ and the change in $\dot{V}E/\dot{V}O_2$ which occurs without a change in $\dot{V}E/\dot{V}CO_2$ (6, 11, 12, 18). As the exercise intensity was further increased, the metabolic phase changed from the aerobic-anaerobic transition (AAT: mid-point between AerT and AT) phase to anaerobic metabolism.

AT was estimated from the second nonlinear increase in $\dot{V}E$ and $\dot{V}CO_2$, changes in $FECO_2$ and R, and an increase in $\dot{V}E/\dot{V}CO_2$ which cannot be adequately compensated for by hyperventilation (11, 15, 18-20).

## Results

The means and SD of the measurements during maximal exercise are shown in Table 1. The mean $\dot{V}O_2$ max and the mean HRmax were obtained as the results of the maximum aerobic parameters. The 12-min running distance (running speed) was slightly greater than the treadmill running speed, because the latter was obtained during an incremental exercise. There was a high correlation between $\dot{V}O_2$ max and the 12-min running distance ($r = 0.88$, $P < 0.01$).

Table 2 shows aerobic training intensities during the submaximal running exercise. The oxygen intake, heart rate and running speed at AerT, AT and the aerobic-anaerobic transition (AAT) were measured during the treadmill test. Three aerobic training intensities corresponding to the three states were termed light, moderate and heavy exercise intensities.

Fig. 1 shows the protocol of the treadmill running. In this protocol, the running speed during the initial 4-min period was 120 $m \cdot min^{-1}$, which is the speed between walking and running. The work load was then increased stepwise by 10 $m \cdot min^{-1}$ every minute untill exhaustion. The gradient was incresed to 3 % where the speed reached 220 $m \cdot min^{-1}$. The running speed on the treadmill was regarded as the physical intensity to be compared with the oxygen intake and heart rate (physiological intensity) during the exercise.

Fig. 2 shows the relationship between $\% \dot{V}O_2$ max and the treadmill speed. Treadmill speed and $\% \dot{V}O_2$ max corresponding to AerT, AAT and AT are shown. The $\% \dot{V}O_2$ max was linearly correlated with the running speed. The regression equation between the treadmill speed (X) and the $\% \dot{V}O_2$ max (Y) is shown below.

$$Y = 0.416X + 3.8 \; (r = 0.95, \; n = 63; \; P < 0.01)$$

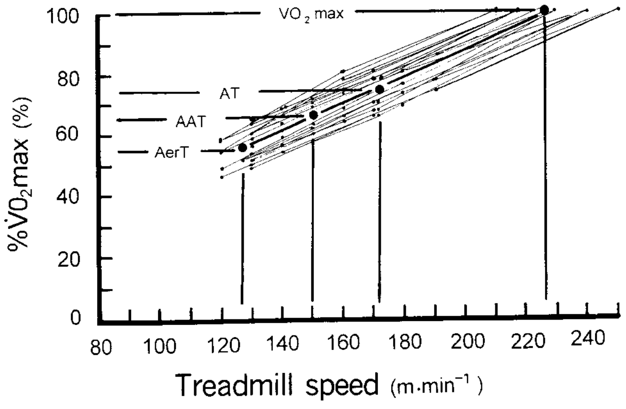

**Fig. 2** Relationship between $\% \dot{V}O_2 max$ (Y) and treadmill running speed (X). AerT: Aerobic threshold; AAT: Aerobic-anaerobic transition; AT: Anaerobic threshold. $\dot{V}o_2 max$: Maximal oxygen intake.

**Table 1** Maximal oxygen intake ($\dot{V}O_2 max$), maximum heart rate (HRmax) and maximum running speed

| $\dot{V}O_2 max$ | $\dot{V}O_2 max/W$ | HRmax | 12-min Run | | Treadmill Speed |
|---|---|---|---|---|---|
| | | | Distnce (m) | Speed ($m \cdot min^{-1}$) | |
| ($l \cdot min^{-1}$) | ($ml \cdot kg^{-1} \cdot min^{-1}$) | ($beats \cdot min^{-1}$) | | | ($m \cdot min^{-1}$) |
| 3.18±0.36 | 51.2±4.1 | 192±6 | 2620±225 | 218±19 | 227±13 |

Values are mean ± SD. W: Body weight. $\dot{V}O_2 max$ (Y) and 12-min running (X) $Y = 0.135X + 16.2$ $r = 0.88$ ($P < 0.01$) $n = 42$

**Table 2** Aerobic training intensities during running exercise

| Exercise intesity | | $\dot{V}O_2/W$ ($ml \cdot kg^{-1} \cdot min^{-1}$) | $\% \dot{V}O_2 max$ (%) | HR ($best \cdot min^{-1}$) | Speed ($m \cdot min^{-1}$) |
|---|---|---|---|---|---|
| Light | AerT | 29.1±3.2 | 55.9±6.4 | 141±8 | 127±5 |
| Moderate | AAT | 33.1±3.1 | 66.0±5.1 | 155±7 | 150±7 |
| Heavy | AT | 38.3±3.0 | 74.7±4.6 | 169±7 | 172±11 |

AerT: Aerobic threshold; AAT: Aerobic-anaerobic transition; AT: Anaerobic threshold. $\dot{V}O_2 max$: See Table 1.

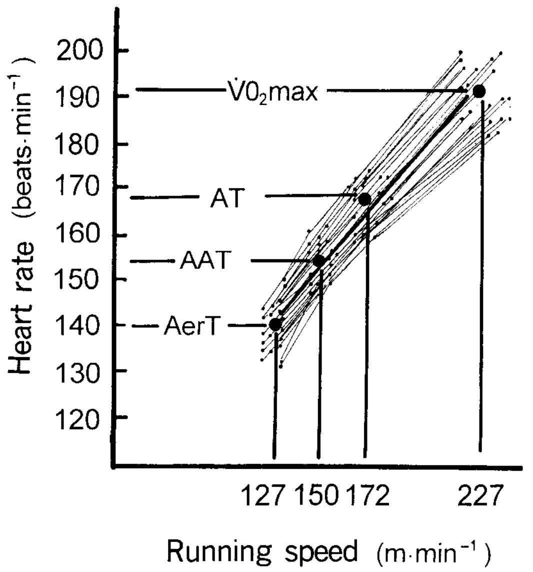

**Fig. 3** Relationship between heart rate, %$\dot{V}O_2$max and running speed in untrained men. $\dot{V}O_2$max, AerT, AAT and AT: See Fig. 2.

The results indicate that the oxygen intake (physiological training intensity) increased linearly as the running speed (physical training intensity) during the submaximal exercise increased.

Fig. 3 shows the relationship between the heart rate and running speed as the training intensities. The regression equations are as follows.

Heart rate (Y) and running speed (X)

$Y = 0.463X + 85.9$ ($r = 0.90$, $n = 63$; $P < 0.01$)

The aerobic training intensity is shown as the range between AerT and AT measured in terms of heart rate or running speed. The running speed, which are the intensities for practical training, corresponded to AerT, AAT and AT.

From the results shown in Figs. 2, 3 and Table 2, the upper limit of aerobic training intensity for measurements during submaximal exercise can be estimated by the mean + SD of the measured heart rate and relative oxygen intake (HR = 180 beats·min$^{-1}$, 80 % $\dot{V}O_2$ max).

## Discussion

The maximal oxygen intake ($\dot{V}O_2$ max) is equivalent to the maximum energy that can be produced per unit time in the aerobic process, and is considered to reflect the capacity of endurance exercise (1, 2). Usually, the 12-min running test is performed as a field test for measuring the capacity of endurance running (16). Cooper (21) found a high correlation ($r = 0.9$, $P < 0.01$) between maximal oxygen intake and the 12-min running distance about US Air Force soldiers. Therefore, he employed the 12-min running distance to estimate the aerobic fitness. In the present study, we confirmed this on untrained healthy men (Table 1). The maximal speed at the maximal oxygen intake on a treadmill was similar to the speed during the 12-min run. These findings demonstrate the correlation between maximal oxygen intake as an index of physiological training intensity and the 12-min running distance (speed) as an index of physical training intensity.

It is difficult to measure oxygen intake during submaximal running exercise, because the choice of the protocol varies depending on the purpose and the subject. AerT and AT have been measured using a bicycle ergometer (6, 9, 12-15, 18, 24, 25) or a treadmill (4, 5, 10, 22). However, running speed cannot be measured when the former method is used, and in the latter, no protocol has been established to measure running speed. In this study, We have designed a protocol which enables simultaneous measurements of the running speed, AerT, AT and $\dot{V}O_2$ max during running exercise on a treadmill (Fig. 1).

Using this protocol, a linear correlation between $\dot{V}O_2$ and running speed was found (Fig. 2). There was also a linear correlation between heart rate and running speed (Fig. 3). Based on these relationships among running speed and physiological training intensities, it is possible to determine the appropriate lap time to be used as a training goal.

Training intensity has been represented by %$\dot{V}O_2$ max and %HRmax relative to the $\dot{V}O_2$ max and HRmax. However, these values are not generally regarded as directly representing energy metabolism (10). In this study, the aerobic training intensities were adapted to the values of AerT, AAT and AT determined based on energy metabolism which were measured by the incremental running speed method.

Skinner and McLellan (11) divided the energy metabolic process, which changes progressively from the rest-state to the maximal training intensity during incremental exercise, into three phases: aerobics, aerobic-anaerobic transition and anaerobics, based on the blood lactate concentration, heart rate and gas exchange variables. Kinderman *et al.* (10) and Schwaberger *et al.* (22) also recognized these three phases, supporting the view that aerobic training intensity can be classified into three levels based on energy metabolism.

Exercise performed up to AerT is steady-state exercise at low training intensity with aerobic metabolism. In the present study, the speed at AerT was 127 m·min$^{-1}$ (58.3 % of the 12-min running speed), which was the boundary between walking and running, and the lower limit of the running speed.

The AerT as a respiratory threshold is the point at which expiratory gas parameters such as $\dot{V}E$ and $CO_2$ start to change due to increased blood lactic acid levels (6, 11, 12, 18). This increase in the blood lactic acid level in healthy, untrained adults has been reported to occur from 50-55 %$\dot{V}O_2$ max (1, 10, 11, 25). In this study, it was almost same value (55.9 %$\dot{V}O_2$max). Therefore, AerT was considered minimum (light) training intensity.

The minimum training intensity that improves aerobic capacity has been reported to be 50-60 %$\dot{V}O_2$ max based on training experiments (1, 20, 22). In another report in which the heart rate was measured as an index of intensity, the minimum intensity of an efficient training was estimated to be 130-140 beats·min$^{-1}$ (7, 8, 23). In the present study, the AerT-HR was found to be 141 beats ·min$^{-1}$, showing that the training intensity at AerT is the lower limit of effective aerobic training.

The anaerobic threshold, where the blood lactate concentration is about 4 mmol·l$^{-1}$, is regarded as the highest training intensity at which the metabolism remains in a steady-state (10-12, 15, 26, 27). At training intensities higher than this, exercise becomes anaerobic due to increased lactic acid levels. It is generally believed that a further increase in the training intensity above AT causes the expiratory gas parameters ($\dot{V}E$, $\dot{V}CO_2$, $\dot{V}E/\dot{V}O_2$ and R) to change (11, 12, 15, 19). These findings show that the training intensity at AT is the maximum (heavy) intensity of aerobic exercises.

It has been reported that there is a close correlation with the records of a 10 km-run at AT (27, 28) and also that the blood lactate level of cross-country skiers remains unchanged during a 30-min endurance run at AT (10). Nagel *et al.* (26) found that for healthy, untrained adults runnig for 30-60 min at the intensity of 67-74 %$\dot{V}O_2$ max caused only a slight increase in the lactate concentration and that endurance running is possible at this intensity. In the present study, the %$\dot{V}O_2$ max and heart rate at AT were 74 %$\dot{V}O_2$ max and 169 beats·min$^{-1}$, respectively. The running speed at this intensity is 74,8 % of the 12-min running speed and at a level where continued endurance running at submaximal exercise is possible.

The values of AerT and AT vary considerably among reports. The AerT ranges from 40 to 60 %$\dot{V}O_2$ max (11) and for healthy, untrained men from 51 to 59.5 %$\dot{V}O_2$ max (4, 25). The AT ranges from 65 to 90 %$\dot{V}O_2$max (11) and it is from 61 to 78 %$\dot{V}O_2$ max for healthy, untrained men (10, 12, 14). Such large differences seem to be caused by exercise load, method, protocol, age, sex and training level. To measure training intensity, it is, therefore, important to employ a protocol suitable to the subjects. In this study, we clarified the training intensity measured at AerT and AT in healthy, untrained men.

Since exercise at maximum effort which requires the subject's physical exhaustion is painful and may expose the subject to unnecessary health risks (3, 6, 25). Therefore, it is necessary to define the end point for the determination of the training intensity during submaximal exercise. We have suggest the means + SD of %$\dot{V}O_2$ max and heart rate at AT as the end point values, which are 85 %$\dot{V}O_2$ max and 180 beats·min$^{-1}$. The heart rate of all subjects at AT was below 180 beats·min$^{-1}$, indicating the validity of our method.

## References

1. Astrand PO and Rodahl K: Textbook of Work Physiology. McGraw-Hill, New York (1970) pp 279-324.
2. Sharkey JB: Physiology of Fitness. Human Kinetics Publishers, Illinois (1984) pp 18-54.
3. Drygas W, Jegler A and Kunski H: Study on threshold dose of physical activity in coronary heart disease prevention: Part I. Relationship between leisure time, physical activity and coronary risk factors. Int J Sports Med (1988) **9**, 275-278.
4. Goodman LS, McKenzie DC, Taunton JE and Walters MB: Ventilatory threshold and training heart rate in exercising cardiac patients. Can J Sport Sci (1988) **13**, 220-224.
5. Sullivan M, Ahnve S, Froelicher VF and Meyers J: The influence of exercise training on the ventilatory threshold of patients with coronary heart disease. Am Heart J (1985) **109**, 458-463.
6. Wasserman K, Whipp JB, Koyal NS and Beaver LW: Anaerobic thresh old and respiratory gas exchange during exercise. J Appl Physiol (1973) **35**, 236-243.
7. Liang TCM, Alexander FJ, Taylor LH, Serfass CR, Leon SA and Stull GA: Aerobic training threshold; intensity, duration and frequency of exercise. Scand J Sports Sci (1982) **4**, 5-8.
8. Shephard RJ: Intensity, duration and frequency exercise as determinants of the response to a training regime. Int Z Angew Physiol (1968) **26**, 272-278.
9. Katch LV, Weltman A, Sady S and Freedson P: Validity of the relative percent concept for equating training intensity. Eur J Appl Physiol (1978) **39**, 219-227.
10. Kindermann W, Simon G and Keul J: The significance of the aerobic-anaerobic transition for the determination of work load intensities. Eur J Appl Physiol (1979) **42**, 25-34.

11. Skinner SJ and McLellan HT: The transition from aerobic to anaerobic metabolism. Res Q Exercise Sprots (1980) **51**, 234-248.
12. Davis HA, Bassett J, Huges P and Gass GC: Anaerobic threshold and lactate turnpoint. Eur J Appl Physiol (1983) **50**, 383-392.
13. Whan SK, Ichimaru N, Kagimura M and Ishii M: Effects of nutrition conditions on relationships between anaerobic threshold and lactate threshold. J Hum Ergol (1983) **18**, 181-189.
14. Lopategui E, Perez HR, Smith KT and Otto MR: The anaerobic threshold of elite and novice cyclists. J Sports Med (1986) **26**, 123-127.
15. Reinhard U, Muller PH and Schmulling RM: Determination of anaerobic threshold by the ventilation equivalent in normal individuals. Respiration (1979) **38**, 36-42.
16. Nakanishi M, Iwasaki M, Yamamoto K, Isogawa M, Kanamoto M, Sakuma H, Masumoto N and Sakai M: Physical Fitness Standards of Japanese People. Tokyo Metroplitan Univ. Labo. of P.E. 4th Ed, Fumaido, Tokyo (1989) pp 236-269 (in Japanese).
17. Ikegami Y, Miyamura M, Matsui H and Saito M: Development of on-line measurement system for aerobic and anaerobic work capacity. Decents Sports Sci (1984) **4**, 137-145 (in Japanese).
18. Caiozzo JV, Davis AJ, Ellis FJ, Azus LJ, Vandagriff R, Prietto AC and Mcmaster CW: A comparison of gas exchange indices used to detect the anaerobic threshold. J Appl Physiol (1982) **53**, 1184-1189.
19. McLellan TM: Ventilation thresholds may be misinterpreted with the presentation of mean data. Can J Appl Sport Sci (1985) **10**, 62-63.
20. Davis AJ, Vodak P, Wilmore JH, Vodak J and Kurtz P: Anaerobic threshold and maximal aerobic power for three modes of exercise. J Appl Physiol (1976) **41**, 544-550.
21. Cooper HK: The New Aerobics. M Evans and Company, Inc., New York (1970) pp 27-30.
22. Schwaberger G, Pessenhofer H and Schmid P: Anaerobic threshold; Physiological Significance and Practical Use. Plenam Press, New York (1980) pp 561-567.
23. Sharkey JB: Intensity and duration of training and the development of cardio-respiratory endurance. Med Sci Sports (1970) **2**, 197-202.
24. Poole CD and Gaesser AG: Response of ventilatory and lactate thresholds to continuous and interval training. J Appl Physiol (1985) **58**, 1115-1121.
25. Weltman A, Kach LV: Relationship between the onset of metabolic acidosis (anaerobic threshold) and maximal oxygen uptake. J Sports Med (1979) **19**, 135-142.
26. Nagle F, Robinhold D, Howley E, Daniels J, Baptista G, and Stoedefalke K: Lactic acid accumulation during running at submaximal aerobic demands. Med Sci Sports (1970) **2**, 182-186.
27. Powers KS, Dodd S, Deason R, Byrd R and Mcknight T: Ventilatory threshold, running economy and distance running performance of trained athletes. Res Q Exercise Sport (1982) **54**, 179-182.
28. Cisar JC, Thorland GW, Johnson OG and Housh JT: The effect of endurance training on metabolic responses and the prediction of distance running performance. J Sports Med (1986) **26**, 234-238.

---

Received October 26, 1993; accepted February 6, 1995