นิพนธ์ต้นฉบับ

A comparative study of Vo_2max and anaerobic threshold between aerobic and non-aerobic exercising in different aged males

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This study was to compare the cardiopulmonary capacity between 17-30 and 31-40 year-old of aerobic and non-aerobic exercising males. The Vo_2max and anaerobic threshold (AT) of 65 healthy men (17-40 year-old) were measured by direct gas analysis during exercise (Spiro-Ergometry). The parameters were declining significantly with age of both groups. The values of Vo_2max and AT of aerobic exercising subjects were significantly higher than of non-aerobic exercising ones ($p < 0.001$).

This study revealed that the declining rate of cardiopulmonary capacity aging could be decelerated by regular aerobic exercise.

Key words : *Vo_2max, Anaerobic threshold, Aging, Fitness.*

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ชาญวิทย์ โคธีรานุรักษ์, บังอร ชมเดช, พัสมณฑ์ คุ้มทวีพร, เจริญทัศน์ จินตนเสรี, ออง มินท์. การศึกษาเปรียบเทียบค่าวีโอ 2 แมกซ์ และแอนแอโรบิค เทรสโฮลด์ ในผู้ชายที่มีกิจกรรมการออกกำลังและไม่ได้ออกกำลังแบบแอโรบิคในระดับอายุต่าง ๆ. จุฬาลงกรณ์เวชสาร 2534 กรกฎาคม; 35(7): 443-449

การศึกษานี้มุ่งเปรียบเทียบค่าสมรรถภาพการทำงานของหัวใจและปอดของชายไทยอายุระหว่าง 17-30 และ 31-40 ปี ที่มีและไม่มีกิจกรรมออกกำลังแบบแอโรบิค โดยวัดค่าสมรรถภาพการใช้ออกซิเจนสูงสุด (Vo_2max) และค่าการใช้ออกซิเจนสูงสุดที่ร่างกายยังออกกำลังได้โดยไม่เกิดการสะสมของกรดแลคติก (AT) ด้วยวิธีวิเคราะห์แก๊สโดยตรง พบว่า ค่าตัวแปรทั้งสองจะลดลงในกลุ่มที่อายุมาก แต่จะสูงในกลุ่มที่มีกิจกรรมออกกำลังแบบแอโรบิค จากการศึกษานี้ แสดงให้เห็นว่า การมีกิจกรรมออกกำลังแบบแอโรบิคอย่างสม่ำเสมอสามารถชลอความเสื่อมของระบบไหลเวียนเลือดและปอดจากความชราได้

Aerobic training could alter physiologic changes in the cardiopulmonary system. They must engage in a prolonged exercise in order to improve cardiopulmonary fitness rather than physical strength and flexibility.(1) The improvement of performance brought about by endurance training for at least one year could be correlated with the increasing in lung compliance as well as in the efficiency of oxygen removed from the air and diffused into the blood.(2,3) The total of the changes were expressed in a higher Vo_2max,(4) or anaerobic threshold (AT).(5) The Vo_2max is the ability of the individual to utilize the greatest amount of oxygen of the whole body. It has been a highly reproducable parameter related to cardiac output and the arteriovenous oxygen difference.(6) At is a level of oxygen uptake above aerobic energy production, which was supplemented by anaerobic metabolism.(7,8) Later parameter has been used to determine peripheral factors such as capillary density or enzyme activity of skeletal muscle.(9)

The lower Vo_2max found in old rat and after training both age groups had increased Vo_2max above sedentary age-matched controls.(10) The decreasing in strenuous activity with age might account for the large reduction in Vo_2max(11) and AT.(12) Until now, the relationship between aging and exercise in human subjects are unsolved.(13,14)

This study was undertaken to define normal range of aerobic parameters and compare the general endurance capacity by both Vo_2max and AT of aerobic and non-aerobic exercising in different aged males. Furthermore, the data will be summarized and added to further study in an attempt to define normal range of aerobic parameters.

Materials and methods

Subjects

Sixty five healthy males (17-40 year-old) were included in this study. The subjects were divided into two groups by age. Each age group was randominized to aerobic and non-aerobic exercising groups by a questionnaire (table 1). Aerobic exercising group is the group of subjects who performed aerobic exercise at least 30 minutes in every other days or not less than 3 days a week. The period of aerobic exercise in this group is not less than 12 months and still maintained exercising activity prior to the test. Non-aerobic exercising group is the group of subjects who do not perform regular aerobic exercise in daily life.

Materials and Methods

On the day of experiment all subjects had a rest for 6-8 hours(15) and omitted heavy diet 3-4 hours prior to the exercise test.(16) The subjects were measured for weight, height (Detecto, U.S.A.), vital sign and blood pressure (Eudameter, German) before the exercise test. The exercise test was set on a braked cycle ergometer (Monark, Sweden). During the experimental period, subjects were advised to rest on cycle ergometer for 10 minutes. All subjects were allowed to breath room air through a mouthpiece (a liter respirometer mouth piece, Collins), a three-way value with 90 ml. dead space, a pneumotachograph (Fleisch i/a 7320 (2 #), U.S.A.), a differential pressure transducer (PT5A Grass, U.S.A.), a 13 litters mixing chamber, an oxygen analyzer (OM-11 Beckman, U.S.A.) and a carbon dioxide analyzer (LB-2 Backman, U.S.A.). Thermo'probe (Surface Temperature-Banjo Type 408, U.S.A.) was a detector of temperature in the chamber which was recorded by telethermometer (Temp I, Thailand). All the signals were recorded on chart paper by a multi-channel polygraph (7DAC Grass, U.S.A.).

When the exercise test started the subjects exercised following audio-visual feedback which rhythm monitored by metronome (Seiko, Japan). The metronome was set at 50 round per minute. The pedaling was begun at 300 kilopond-meter (kpm). The resistance was increased by 50 kpm every minute until exhaustion. Then subjects went on pedaling 0 kpm 10 minutes for cooling down purpose.(17)

Calculation

The volume of expired air, expired oxygen percentage and expired carbon dioxide percentage from polygraph recorder were changed to values at standard temperature, standard pressure and dry (STPD) and calculated to volume per minute by method of Jones.(4) The highest volume of oxygen in a certain minute was the value of Vo_2max.

The graphs of volume of oxygen uptake (Vo_2), volume of carbon dioxide output (Vco_2) and volume of expired air (V_E) at STPD against time scale were used to determine the value of AT under 2 criterias that:- the increase of Vco_2 and V_E were non-proportional to the work load, while the increasing Vo_2 was still linear to the work load.(18)

Statistics

The statistics used to determine the difference of aerobic parameters in each aged group was F-test (Analysis of Variance) using the statistic computer program "Epistat". The physiological differences between aerobic and non-exercising groups were also tested by F-test. A probability of 0.05 was selected as the criterion for statistical significance.

Results

Table 1 demonstrated that the mean values of all physical characteristics were not statistically significance ($p < 0.05$). Table 2 showed that the mean value of Vo_2max of non-aerobic exercising subject was not change with age. In aerobic exercising groups, the mean value of Vo_2max of younger aged group was significantly higher than the older one ($p < 0.01$). The comprison between aerobic and non-aerobic exercising subjects indicated that the Vo_2max of both 17-30 and 31-40 year-old aerobic exercising ones were significantly higher than of non-aerobic exercising in the same aged groups ($p < 0.001$).

The data from table 3 demonstrated that the changes of AT in different aged groups were statistically significance ($p < 0.01$ and $p < 0.001$). The comparison between aerobic and non-aerobic exercising subjects showed that the mean values of AT of aerobic exercising were higher than non-exercising significantly in both aged groups ($p < 0.001$).

Table 1. Selected characteristics of subjects of exercise activity.

Characteristics	Exercise activity		p value
	aerobic	non-aerobic	
Age group 17-30 yrs	n = 15	n = 15	
($\bar{X} \pm SD$)			
Age (yrs)	24.80 ± 4.23	25.47 ± 2.45	0.60
Weight (Kg)	60.80 ± 5.43	61.50 ± 7.91	0.78
Height (cm)	170.13 ± 5.95	170.07 ± 3.37	0.97
Age group 31-40 yrs	n = 16	n = 19	
($\bar{X} \pm SD$)			
Age (yrs)	36.06 ± 3.55	36.05 ± 2.93	0.99
Weight (Kg)	64.53 ± 5.32	66.63 ± 9.72	0.45
Height (cm)	170.56 ± 4.26	168.84 ± 5.48	0.31
p value of weight	**0.06**	**0.11**	

Table 2. The Vo_2max of subjects (mean ± SD).

Age (years)	Vo_2max (ml/min/kg)		p value
	aerobic exercise	non-aerobic exercise	
17-30	60.61 ± 4.01 (1)	44.86 ± 4.18 (2)	(1) > (2), $p < 0.001$
31-40	54.72 ± 5.26 (3)	43.76 ± 7.49 (4)	(3) > (4), $p < 0.001$
p value	(1) > (3) $p < 0.01$	(2) > (4) NS	

Table 3. The AT of subjects (mean ± SD).

Age (years)	AT (ml/min/kg) aerobic exercise	AT (ml/min/kg) non-aerobic exercise	p value
17-30	45.21 ± 5.30 (1)	33.52 ± 4.32 (2)	(1) > (2), $p < 0.001$
31-40	38.68 ± 5.99 (3)	26.74 ± 4.98 (4)	(3) > (4), $p < 0.001$
p value	(1) > (3) $p < 0.01$	(2) > (4) $p < 0.001$	

Discussion

The recent study has reported that the optimal of a direct exercise test of Vo_2max was approximately 8-17 minutes.[19] In this study, the duration of 8-16 minutes was used and showed that the highest value of Vo_2max in each test was not interfered by limitation of muscular force.

The aerobic exercising groups in this study were the subjects who performed aerobic exercise such as jogging, swimming, long distance walking and other aerobic activities in such a period of time. So the values of our aerobic parameters might be varied. But the Vo_2max of 17-30 and 31-40 year-old aerobic exercising subjects were 60.61 ± 4.01 and 54.72 ± 5.26 ml/min/kg, respectively that corresponded with the value of slow runner group that was 53.4 to 67.4 ml/min/kg which demonstrated by Sjodin and Svedengag.[20] The study also agrees with value of previous study of Coyle and his team.[21] The Vo_2max of 17-30 and 31-40 year-old non-exercising subjects were 44.86 ± 4.18 and 43.76±7.97 ml/min/kg, also agree with previous study.[22]

The AT in our study was higher than AT of obesity subjects.[23] The AT of non-exercising subjects was agree with AT of previous studies.[24,25] The AT of aerobic exercising subjects was higher than the AT of jogging persons in previous sutdy.[26] These might be due to our study being performed with more intensity and longer duration of aerobic exercise.

The age effect was not due to differences in body weight, since no significant difference in body weight was found between the groups of the study (table 1), and the difference in Vo_2max and AT were evident whether it was expressed relative to body weight (ml oxygen/min/kg body weight).

Both Vo_2max and AT decline with age. Vo_2max is the product of maximal cardiac output and maximal systemic arteriovenous oxygen difference,[6] and AT correlates with muscle oxidative capacity.[27] Most studies reported that maximal cardiac output declines with age because of a decrease in maximal heart rate associated with a decreased in Vo_2max with age.[28] The reduction in oxygen uptake at the ventilation threshold in elderly was stated by Seals and colleagues.[29] They indicated that this decline resulted from the limitation of the respiratory and hemoglobin oxygen transport system responding to facilitate tissue oxygenation in the elderly. The means Vo_2max in aerobic exercising groups were different significantly from those of non-aerobic exercising groups (table 2) and the results were acceptable as compared to the study of the athlete groups[30] and the sedentary groups.[31]

Table 3 demonstrated that aerobic exercising groups showed higher AT than non-aerobic exercising groups which agree with previous studies.[28,32] These AT also declined with age in the same manner as those of the study of Allen and co-workers.[33] Accordance with the result from Hagberg and co-workers,[30] that undergo less metabolic response than younger ones. Dudley et al.,[34] suggest that the signal that stimulates increased respiratory capacity might be influenced by the adaptation "itself". Unfortunately results of both areas are still not available for discussion, so that further studies are valuable.

The Vo_2max in this study was not different from other races in previous studies, whereas AT of aerobic-exercising subjects was higher than previous studies in caucasian. Both aerobic exercising groups showed higher cardiopulmonary capacity than non-aerobic exercising ones. These findings suggest that although central and peripheral circulation and pulmonary function declined by aging, the regular aerobic exercise can decelerate these processes in both age levels study. Further study will give our team more valuable data of aerobic parameters to define normal range of them.

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