Response of Cardiopulmonary Function in Middle and Old-aged Men

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In an earlier report[10,14,17,22,23] the physical activity in walking, jogging, tennis and other sports was performed in order to improve our body condition and physical fitness.

It was found[21,20] that a favourable effect of physical activity improved coronary heart disease. Therefore, the number of the people increased who actived to sports event. On the other hand the aerobic capacity is found[2,6,12,20] to decrease with aging in[1] adults. Åstrand[5] and Rodahl reported a 20% drop in PWC in male subjects from 45 to 60 years of age. Saltin and Grimby[19] found a 20 to 31% decline in $\dot{V}O2$ max in nonsportsmen of 40-54 years of age. This study is meaningful as one approach to observe the changes of the cardiopulmonary function occurring with increasing age.

The purpose of this study was to compare the changes of the cardiopulmonary function in the middle-aged men with that in the old -aged men.

Subjects

The subjects selected for this study were 11 middle and old-aged men. The middle-aged subjects were 5 ranging from 45 to 55 years and the mean age was 49. The group was comprised of four professors and one technician of university. The old-aged subjects were 6 ranging from 62 to 77 years and the mean age was 68. They performed walking for about 30 minutes in early morning. All subjects were non-smokers.

Table 1 presents their descriptive data.

Procedure

After the subjects came to the laboratory in the morning, they rested about 30 minutes in sitting posture. Next, resting heart rate (HR) and blood pressure (BP) were measured. The height and weight of subjects were also measured.

Exercise was performed on a bicycle ergometer (Monark, Sweden) at submaximal work load. Pedaling rate was 50rpm/min.

Expired air was collected in Douglas bag and the volume was measured in a dry gasmeter. Gas samples were analysed with micro scholander analyzer. Expired air was collected during the final minute of exercise at each load. The ECG was continuousiy recorded for each minutes throughout the exercise and recovery time. Heart rate was calculated from ECG record. Blood pressure was measured indirectly using a Rive Rocci sphygmomanomater on the right arm during the final minute of exercise at each load. The blood pressure during recovery was measured immediately after exercise.

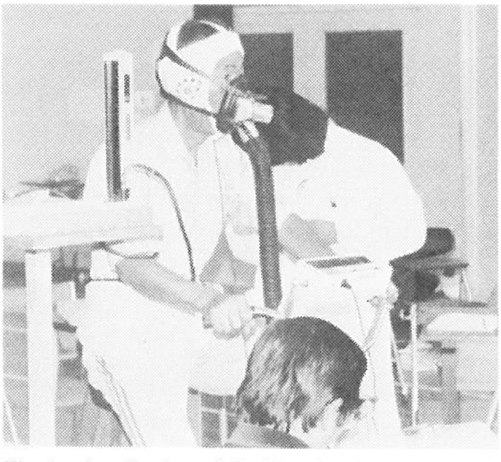

Fig 1. Application of the Douglas bag method for measuring aerobio energy output during exercise on bicycle ergometer.

Table 1. Average and range values of age, height, weight, %fat, blood pressure and rate of resting.

	Age (yr.)	Height (cm)	Weight (kg)	fat (%)	Blood (mmHg)	Rest Pressure	Heart rate (beats/min)
Middle	49± 3	167.4±2.9	61.8± 4.7	15.7± 1.3	111± 8	72± 4	165± 8
aged	45−55	163 −171	53.0−66.5	13.0−19.6	100−118	68−78	52−74
Old	68± 5	161.4± 5.1	51.9± 5.5	10.4± 1.0	128± 22	79±12	62± 6
aged	62−77	156 −169	53.8−61.8	7.8−14.6	102−169	64−98	55−73

Results

Means and standard error for oxygen uptake, heart rate, pulmonary ventilation, respiratory frequency and blood pressure are presented in Table 1. Mean values for oxygen uptake, heart rate, pulmonary ventilation, respiratory and blood pressure increased with an increase of work load in middle and old--aged men.

The average change in the old-aged men were greater than that in the Middle-aged men at each work load (Table 2).

As shown in Fig 2, heart rate increased with work load in the middle and old-aged men. The average change of heart rate in the old-aged men were greater than that in the middle-aged men during the exercise and at recovery time.

Table 2. Results from submaximal work loads : Means and standard error.

Work load (kpm/min)	Age (yr.)	$\dot{V}O_2$ (ℓ/min)	$\dot{V}E$ (ℓ/min)	HR (beats/min)	RR (f/min)	Blood pressure (mm Hg) systolic	Diastolic
225	45−55	0.73	22.49	72.7	19.9	130	80
		± —	± —	± —	± —	± —	—
	62−77	0.70	20.71	85.0	19.0	140	105
		±0.02	± 0.94	± 0.1	± 1.8	± 9	4
300	45−55	0.83	23.60	94.9	16.1	124	83
		±0.04	± 1.29	± 4.2	± 1.5	± 6	2
	62−77	0.85	25.89	94.4	18.4	142	87
		±0.02	± 1.23	± 4.1	± 0.8	± 3	7
375	45−55	0.91	26.59	104.2	18.8	136	83
		±0.04	± 1.27	± 4.6	± 1.0	± 5	2
	62−77	0.93	30.04	107.6	21.7	152	91
		±0.03	± 1.24	± 4.8	± 2.3	± 4	6
450	45−55	1.70	30.86	114.5	20.0	143	86
		±0.06	± 1.28	± 4.7	± 1.3	± 8	4
	62−77	1.13	37.92	119.0	23.9	157	94
		±0.03	± 2.72	± 5.4	± 2.3	± 2	4
525	45−55	1.19	34.84	127.5	21.6	149	82
		±0.53	± 1.82	± 7.0	± 0.8	± 4	3
	62−77	1.28	41.99	134.0	22.7	162	83
		±0.04	± 2.25	± 3.1	± 0.6	± 6	21

However, heart rate in the middle-aged men were greater than that in old-aged men at 1.0 kp work load.

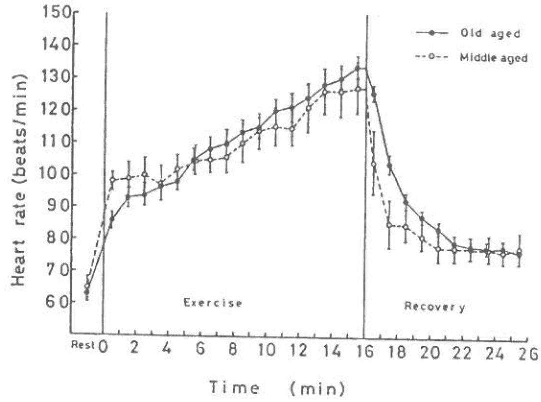

Fig 2. Changes in heart rate due to exercise on bicycle ergometer.

As shown in Fig 3, increase ratio of heart rate in the middle and old-aged men increased with an increase of work load. The average change of increase ratio in the old-aged men were significantly greater than that in the middle-aged men. When subjects rested, the increase ratio of heart rate quickly returned to the level of their resting.

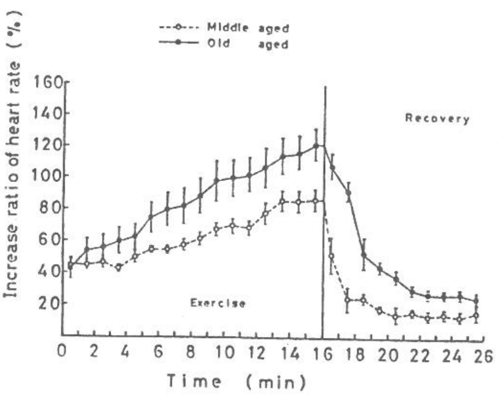

Fig 3. Changes in heart rate (in percentage of the resting value) due to exercise on bicycle ergometer.

The average change of respiratory frequency in the middle and old-aged men increased with an increase of work load (Fig 4). The average change of respiratory frequency in the old-aged men were greater than that in the middle-aged men. When subjects rested, the average change of respiratory frequency in the middle-aged men quickly returned to under the level of resting. However, it was observed that the avereage change of respiratory frequency in the old-aged men was at the steady level during recovery.

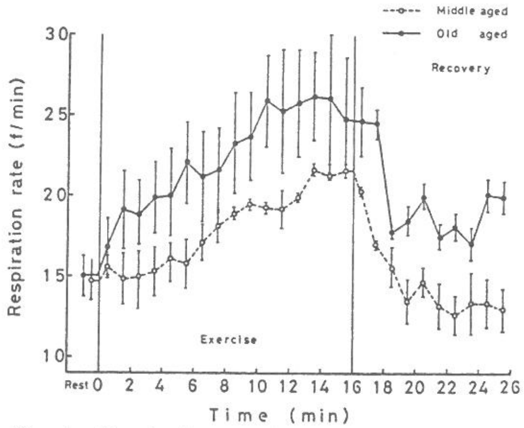

Fig 4. Respiration rate due to exercise on bicycle ergometer.

The oxygen uptake during submaximal exercise increased with an increase of work load in the middle and old-aged men. The

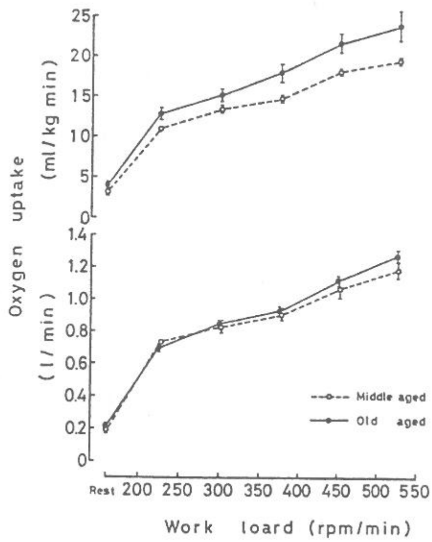

Fig 5. Change in oxygen uptake with exercise intensity.

average change of oxygen uptake in the old-aged men was greater than that in the middle-aged men at each load (upper of Fig 5).

As shown in Fig 6, heart rate and pulmonary ventilation increased with an increase of oxygen uptake in the middle and old-aged men.

The significant high correlation coefficient was found between heart rate and oxygen uptake in the middle and old-aged men ($p < 0.01$). There is no significant differnce between the middle-aged and old-aged men in corresponding values for heart rate and pulmonary ventilation.

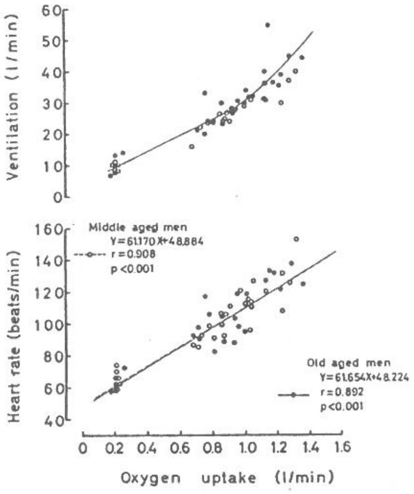

Fig 6. Heart rate and ventilation in relation oxygen uptake during bicycle exercise.

In the oxygen uptake ranging between 0.2 and 1.4 ml/min, there was a linear relationship between average blood pressure and oxygen uptake in both group (Fig 7). The significant high correlation cofficent was found between oxygen uptake and systolic blood pressure in the middle and old-aged men.

However, there is no significant diastolic blood pressure in the old-aged men.

The Fig 8 showed relationship between work load and percentage of maximal oxygen uptake (%$\dot{V}O2$max) for the middle and old-aged men. % $\dot{V}O2$ max increased with work load in the both group.

However, % $\dot{V}O2$ max in the old-aged men was greater than that in the middle-aged men at each work load.

In this study, maximal oxygen uptake was determined by calculative equation.

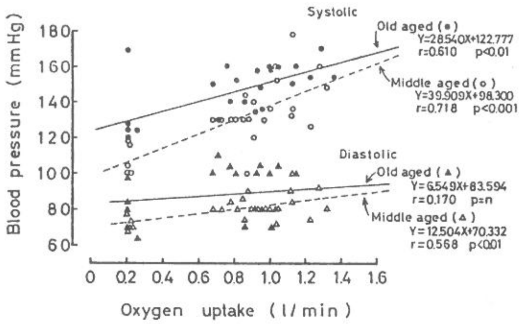

Fig 7. Relationship between blood pressure and oxygen uptake in the middle and old-aged men

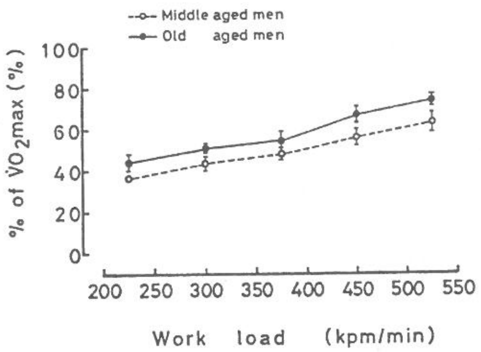

Fig 8. Change in % $\dot{V}O$ max with exercise intensity.

Discussion

It was found[2] that oxygen consumption increased with an increase of work intensity in exercise. On the other hand, Åstrand[2] has reported that heart rate increased with an increase of oxygen uptake in exercise.

In this studay, heart rate change in exercise become greater with work load, but the change of heart rate in the old-aged men were somewhat higher than that in middle-aged men.

Increase of ratio of heart rate in the old-aged men was greater than that in middle-aged men. Yamaji[24] has reported that heart rate in the old-aged men decreased than that in young -aged men during maximal exercise.

Can this dscrease be shown with aging ? Åstrand[2,6] has reported a decrease in maximal aerobic power with the aged. In this study, the respiratory freqency in the old-aged men increased with an increase of work load than that in middle-aged men. However, respiratory frequency in the old-aged men was slow in recovery after exercise. Sato et al.[18] have reported that respiratory in the old-aged men increased at submaximal exercise.

In this study, heart rate in the old-aged men was lower than that in middle-aged men under 1.0 kp work load.

It seemed to be a progressive decline in the functional capacity of the cardiovascular system with aging.

In this study, oxygen uptake (ml/kg/min) in the middle and old-aged men increased during exercise at work load. Several investigater[1,3,9,13] have reported that heart rate increased with an increase oxygen uptake in exercise. Results of this study are quite simelar with the results of thier investigaton.

Recent studies[1,13] have shown that the relationship between oxygen uptake and heart rate was liner relation during submaximal exercise on bicycle ergometer. Åstrand reported a decrease in maximal aerobic power with aged. Shehard et al.[20] have reported that the efficency of young people (23.0%) was higer than that in the old-aged men (21.5%) on bicycle ergometer.

Robinson et al.[25] have reported a decline of approximately 22% at PWC in the middle-aged men. In this study, $\%\dot{V}O_2$ max in old-aged men was higher than that in middle-aged men at each work load. It was suggested that the old-aged men was lower that the middle-aged men in aerobic capacity.

Blood pressure[9,18] is known to increase during exercise. In this study, the systolic blood pressure increased with oxygen uptake.

The linear relationship was found between oxygen uptake and systolic blood pressure. Åstrand[21] has reported that blood pressure increased linearly with oxygen uptake during exercise on bicycle ergometer. Sato et al.[18] have reported that systolic blood pressure and the pulse pressure increased with work load. By Asahina[9], the systolic blood pressure during exercise increasedwith an increase of oxygen uqtake. On the other hand, the stroke volume is known[2] to decrease in very old untraine individuals[3,16,18].

On of the reasons of the difference in blood pressure response during exercise may be awing to different ability to raise the cardiac output reported by several investigators.

Summary and conclusions

The purpose of this study was to compare the changes of the cardiopulmonary function in the middle-aged men with that in the old -aged men. Heart rate, oxygen uptake, pulmonary ventilation, respiratory frequency and blood pressure during submaximal exercise were determined in 11 men 44 to 76 years old.

Theie results were summarizsd as follows :

1) Mean values for heart rate, oxygen uptake, pulmonary ventilation, respiratory frequency and blood pressure increased with an increase of work load in the middle and old-aged men.
2) The linear relationship was found between oxygen uptake and heart rate during submaximal exercise in the middle and old-aged men.
3) Systolic blood pressure increased with an increase of oxygen uptake in the middle and old-aged men.
4) The average change of systolic blood pressure in the old-aged men was greater than that in the middle-aged men.

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