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ABSTRACT

Fifty-six healthy nontrained women aged 18 to 48 were tested for maximal work capacity on a bicycle ergometer. The women were divided into three age groups. A continuous step-increment bicycle ergometer work test was administered with the workload starting at 150 kpm (kilometers per minute) and 50 pedal rpm (revolutions per minute). The workload was increased by 150 kpm each minute for three minutes, then increased to either 75 or 150 kpm until exhaustion, depending on individual response. The following measurements were made during or immediately following maximal work: oxygen consumption, heartrate, blood pressure, minute ventilation, and workload. Oxygen pulse and workload at heartrate 150 were determined from measured values, and descriptive statistics were calculated for all variables. The effects of age were examined by comparison of the three groups and with results of similar investigations. Decreases in peak oxygen consumption, maximal heartrate, and maximum workload were found to occur as age increased, but slight increases in heartrate 150 and diastolic blood pressure were noted as age increased. No age-related trends were found in systolic blood pressure, maximal ventilation volume, or oxygen pulse. (Authors/JA)

EFFECTS OF AGE ON MAXIMAL WORK CAPACITY IN WOMEN AGED 18-48 YEARS

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The decline in maximal working capacity with age as determined by aerobic capacity and associated physiological measurements has been well documented in men in both cross-sectional and longitudinal studies. Some similar cross-sectional information is available concerning women in Sweden (1,6), Canada (2), and Japan (5) but the only such study of women in the U.S. (8) utilized the treadmill, which commonly produces VO_2 max. approximately 10%--15% higher than the bicycle ergometer. The purpose of this study was to attempt to add to the knowledge of the effects of aging on maximal exercise responses of American women during cycle ergometer exercise.

Fifty-six healthy women aged 18 to 48 years volunteered as subjects. Three groups were formed based on age, 18-29 (N=20), 30-39 (N=21), and 40-49 (N=15). Most subjects were sedentary or only moderately active, and only three engaged in regular exercise (only one of these was endurance type.) Some members of the younger two groups were tested prior to starting a group fitness program.

A continuous step-increment cycle erometer work test was administered using a Monarch type ergometer. The workload started at 150 Kpm/min each minute for two minutes then by 75 or 150 Kpm/min-1 until exhaustion depending on individual response. Oxygen consumption was determined using a Technology Inc. Oxygen Consumption Computer which had been validated using gas chromatography. Heart-rate was monitored electrocardiographically and expired ventilation volume was measured using a high-velocity dry gas meter and corrected to BTPS. Blood pressure was obtained using the cuff method within 20 seconds following the cessation of work. Oxygen pulse and workload at heart-rate 150 (W150) were computed from measured values. These methods have been described in more detail elsewhere (4).

Results

Mean VO_2 max. declined as expected from the 18-29 group to the 30-39 group, but not from the 30-39 to 40-49, (only 0.04 l.). The same was true with VO_2 max. expressed per kg. of body weight. This may be because in this older age group women volunteered only when they thought they were relatively fit (all three subjects mentioned previously as exercising regularly were in the older age group).

Maximum heart rates declined with age somewhat was expected. These means are not as high as the usually quoted "predicted" maximum heart rates, but are above 90% of these values. No age trends were observed in ventilation volume. Mean maximum workload declined as would be expected even though the range within each group was the same.

Systolic and diastolic blood pressures did not show a definite pattern, but there was a tendency for maximum systolic BP to decrease with age and diastolic BP to increase. Oxygen pulse also did not show a definite declining trend because of the higher values for the older age group over the middle group. This was attributable to the lower maximum heart rate, but nearly equal VO_2 max. in the older group. The age effect in W150 (increase in workload with age) was expected and is caused by the lower maximum heart rate in older subjects being reached at a point nearer the maximum workload (HR 150 is nearer maximum heart rate).

Discussion

In comparison with groups of nontrained women previously tested for aerobic capacity, our group would seem to be lower (3). Our results are very comparable with those of Michael and Horvath (7) who used the same testing procedures. The 30-39 age groups falls well below the Astrand Swedish group (1) in aerobic capacity but the 40-49 group is very near to the treadmill tested Profant (8) group of the same age.

Several factors must be taken into consideration when making such comparisons: (1) Type of work (as previously mentioned treadmill tests yield higher max. VO_2 than bike, usually). (2) Continuous or discontinuous test. In some studies the discontinuous test yields higher VO_2 max. on the bike. (3) Subjects--P.E.majors, college students, active or sedentary adults. (4) Country--Europe vs. U.S. women in other parts of the world have traditionally been more active or more fit for heavy work than American women.

It is thought that use of the bicycle ergometer and the continuous type test resulted in lower maximum oxygen uptake and possibly lower maximum heart rates than would have been obtained during treadmill exercise. The size of the subjects and their general lack of leg strength and lack of cycling experience are also thought to be factors affecting the results. Local leg fatigue was many times a primary factor in their inability to continue pedalling even though physiological signs indicated that they should have been able to. Motivation was another factor and the women seemed reluctant to push themselves when the "pain" of heavy work begins.

It is thought that the continuous test used was more satisfactory for women who are not highly motivated and who might not attempt a harder workload after a rest, but who might be able to continue for a short time knowing tha the end is in sight. In spite of these shortcomings these results should be more valid in judging the aerobic fitness of the average sedentary U.S. woman measured by cycling than the Astrand data and some of the other cross-sectional studies which probably used more active subjects.

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TABLE 1

Description of Subjects

Age Group	Age (Years)	Weight (Kg.)	Height (cm.)
18-29 N=20	22.7 ± 2.5 (18.2-27.4)	59.69 ± 6.7 (49-73)	161.1 ± 5.5 (152-170)
30-39 N=21	36.4 ± 2.61 (30.3-39.4)	58.65 ± 5.9 (48-72)	164.3 ± 6.2 (150-177)
40-49 N=15	44.1 ± 2.5 (40.5-48.4)	58.87 ± 7.0 (49-77)	164.3 ± 3.9 (156-172)

Means ± Standard deviation and Range

TABLE 2

Response to Maximal Exercise (56 Females)

Age Group	$\dot{V}O_2$ (L/min) STPD	$\dot{V}O_2$ (ml/kg/min) STPD	Maximum Heart Rate	$\dot{V}E$ (L) BTPS	Maximum Workload (kpm/min
18-29	1.69 ± 0.23	28.6 ± 4.3	184 ± 13	56.6 ± 11.8	731 ± 64
N=20	(1.34-2.18)	(21.2-36.2)	(167-214)	(34-80)	(600-825)
30-39	1.48 ± 0.22	25.4 ± 3.9	176 ± 12	55.1 ± 11.7	721 ± 152
N=21	(1.15-2.10)	(19.3-34.3)	(150-196)	(40-90)	(600-825)
40-49	1.44 ± 0.24	24.8 ± 4.6	169 ± 12	56.4 ± 17.9	690 ± 81
N=15	(1.14-1.88)	(18.7-32.2)	(150-188)	(39-93)	(600-825)

Means ± Standard deviation and Range

TABLE 3

Response to Maximal Exercise (56 Females)

Age Group	O_2 pulse (ml/beat)	O_2 pulse (ml/kg/beat)	BP Systolic	BP Diastolic	W_{150}
18-29	9.21 ± 1.4	.155 ± .02	170 ± 21.3	74 ± 7.2	489 ± 101
N=20	(6.7-11.6)	(.120-.197)	(142-210)	(60-92)	(300-600)
30-39	8.41 ± 1.0	.144 ± .02	154 ± 8.7	75 ± 4.5	512 ± 141
N=21	(6.7-11.4)	(.112-.175)	(135-172)	(65-82)	(150-715)
40-49	8.53 ± 1.1	.147 ± .03	160 ± 11.2	76 ± 6.7	550 ± 86
N=15	(6.7-10.2)	(.113-.201)	(144-175)	(62-90)	(450-750)

Means ± Standard Deviation and Range