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CARDIO RESPIRATORY CHANGES ASSOCIATED WITH GRADED EXERCISE AND DETERMINATION OF AEROBIC POWER IN MALE MEDICAL STUDENTS (18-19 YEARS)

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Abstract : The data from the study reveals the normal cardiopulmonary responses in untrained subjects (18-19 yrs) and their aerobic power.

Fifty male medical students in the given age group were selected for the study. They were subjected to moderate, predetermined, graded exercise on a bicycle ergograph and parameters like heart-rate, blood pressure and respiratory rate were recorded at rest, just after exercise and during recovery. $\dot{V}O_2$ max or aerobic power was calculated from Astrand's nomogram after determining work rate. Heart-rate, systolic blood pressure, double-product and respiratory rate rose linearly with increasing grades of exercise, while diastolic blood pressure recorded a fall. Aerobic power was found to be 2.10 litres/min in 18 years age group and 2.07 litres/min in 19 years category. The determination of aerobic power or $\dot{V}O_2$ max gives an idea of the capacity and regulation of O_2 transporting system and also sets a norm in assessing physical fitness.

Key words : ergograph submaximal load $\dot{V}O_2$ max

INTRODUCTION

Exercise testing has been a means of finding out the physical capabilities and physiological responses of an individual (1). Sufficient information is not available on the extent of change observed in different systems in untrained Indian subjects. The present study was therefore undertaken to investigate the cardiovascular and respiratory responses to graded exercise among untrained male medical students (18-19 years).

Graded exercise on a mechanically braked bicycle ergograph was chosen, since progressive work loads can be interspersed with short rest periods, thus giving the subject time to recover before starting next period of exercise (2).

In the absence of any scientific meaning the term exercise has been quantified by measuring the work done in given time. This gives work-rate or power as per following equation.

$$\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{F \times d}{t}$$

Where F = force, d = distance, t = time.

Aerobic power or $\dot{V}O_2$ max or physical work capacity which involves a full functional support from cardiorespiratory and metabolic pathways is an appropriate test to study cardiopulmonary fitness (3).

This study aims to provide a reference data which may serve as a guide for careful monitoring during an exercise procedure.

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METHODS

Subjects were untrained male medical students in the age group of 18-19 years. Fifty normal and healthy males were selected after detailed history and physical examination. The students were asked to report at the Department by 8.30 A.M. Subjects were explained the whole procedure in detail and were motivated prior to the start of exercise. They were told to report immediately if they felt any discomfort, fatigue or dizziness. Subjects rested in supine position for 15 min before the start of exercise.

Choice of load : One day prior to exercise testing the subjects were called to the Department and the maximal load at which they would cycle on the bicycle ergograph was determined. In most of the subjects, maximal load, under study was found out to be 5 kg with a heart rate of about 198 beats/min. The submaximal load which should be within 85-90% of the maximal heart rate at maximal load i.e. in between 168-178 beats/min (4, 5) was found out to be 4 kg after repeatitive testing. For 2 sessions of graded exercise, the recommended load is 2 kg and 4 kg respectively, corresponding to heart rates in between 130 and 170 beats/min (4).

Procedure : The parameters namely pulse-rate was examined by palpatory method, blood pressure, with a mercury sphygmomanometer and respiratory-rate visually. After a rest of 15 min, the subjects performed 2 sessions of graded exercise each lasting for 5 min with a rest of 15 min in between, on a mechanically braked bicycle ergograph (I.N.C.O.). During the exercise, the subjects pedalled the bicycle at the rate of 60 revolutions per minute. At this rate, there is lowest O_2 uptake and greater mechanical efficiency. This rate was kept fixed throughout the exercise sessions. The pulse-rate, blood-pressure and respiratory rate were recorded just after the 5th minute in both the sessions which were termed as S_1 and S_2. Similar recordings were done just before the start of the 2 exercise sessions and after 15 min of rest following the second session. These were designated as R_1, R_2 and R_A respectively. Aerobic

TABLE I : Cardiorespiratory parameters. Their comparision values are highly significant.

S.No.	Parameters	Session I: At rest	Session I: After Session I (R_1)	Session I: S_1-R_1 (S_1)	Sesion II: At rest	Sesion II: After Session II (R_2)	Sesion II: S_2-R_2 (S_2)	15 Minutes after Session II (R_A)
		Mean Range	*Mean Range*	*DTP*	*Mean Range*	*Mean Range*	*DTP*	*Mean Range*
1.	Heart rate (pulse rate in beats/min)	71.7 (68-80)	134.9 (126-146)	63.2 72.9 <0.001	80.2 (70-80)	175.3 (168-180)	95.2 93.4 <0.001	132.8 (108-150)
2.	B.P. systolic in mms of Hg	110.6 (90-120)	122.6 (110-130)	12 9.2 <0.001	111.8 (100-122)	142 (130-160)	30.2 31.4 <0.001	121.1 (90-140)
3.	B.P.diastolic in mms of Hg	75.4 (60-80)	69.6 (60-80)	—5.8 4.2 <0.001	75.6 (60-82)	63.8 (50-80)	—11.8 8.9 <0.001	73 (70-80)
4.	Respiratory rate per min	15.4 (14-18)	24.7 (20-30)	9.3 24.5 <0.001	16.5 (14-18)	32.5 (26-38)	16 31.6 <0.001	25.4 (20-30)

D - Difference
T - Test of significance
P - Probability

TABLE II : Comparison of cardiorespiratoy parameters

S.No.	Parameters		S_1-R_1	S_2-R_2	R_A-R_1
1.	Heart rate (pulse rate) in beats/min	D	63.24	95.16	61.00
		T	72.85	93.38	45.11
		P	<0.001	<0.001	<0.001
2.	B.P. systolic in mins of Hg	D	11.96	30.2	10.52
		T	9.21	31.36	7.79
		P	<0.001	<0.001	<0.001
3.	B.P. diastolic in mms of Hg	D	—5.8	—11.84	—2.4
		T	4.24	8.86	2.12
		P	<0.001	<0.001	<0.01
4.	Respiratory rate per min	D	9.32	15.96	10
		T	24.52	31.60	22.22
		P	<0.001	<0.001	<0.001

TABLE III : Double product (D.P.) and mean arterial pressure (MAP) values.

Parameter	Resting	Session I	Resting	Session II	Recovery
D.P.	7580.4	15578.9	8450.2	23933.2	15148.4
MAP (Mean)	90.9	94.1	92.8	101.0	97.0

D.P. increases with increasing grades of exercise.
MAP shows negligible difference.

TABLE IV : Aerobic power or $\dot{V}O_2$ max in subject under study.

S. No.	Age	$\dot{V}O_2$ max (liters/min) Mean ± SEM
1.	18 years	2.10 ± 0.0047
2.	19 years	2.07 ± 0.0092

T = 3; P<0.001; Highly significant

power was found out indirectly after calculating the work rate in Kpm/min and then using Astrand's nomogram (6). The mean and S.D. were calculated for all observations and statistical significance was found out using 't' test.

DISCUSSION

In this study, heart-rate increased linearly with increasing grades of exercise, which could be due to :-

1. Sympathetic stimulation,
2. Increased venous return and
3. Withdrawal of parasympathetic inhibition.

There was statistically significant increase in hear-rate over the pre-exercise values during both the exercise session, (P<0.001). Also there was persistent increase in the heart rate even after the rest of 15 min following the second session. This could be due to sustained release of catecholamine (7, 8) during submaximal exercise in untrained subjects.

Systolic blood pressure rose linearly with increasing grades of exercise. The result is statistically significant and is in line with findings of other workers (9). Decrease in systolic blood pressure during recovery is due to a decrease in cardiac output.

Decrease in diastolic B.P. in both the sessions of exercise may be due to epinephrine acting on vascular B_2 receptors. Change in diastolic B.P. was minimal (10-15 mms of Hg) as compared to change in systolic B.P. (30-40 mm Hg). Mean arterial pressure was found to change very little since changes in systolic and diastolic B.P. are opposite in direction which is consistent with earlier work (9).

Double-product of heart-rate and systolic B.P., also called as myocardial-tension-time index (M.T.T.I), gives an index of myocardial oxygen consumption (10). It showed a linear increment and being an index of myocardial O_2 consumption, showed a gradual fall during recovery.

Respiratory-rate increased in both the sessions of exercise. This result could be due to a rapid neurogenic component and a slower humoral component according to the neurohumoral theory of exercise hyperpnea.

$\dot{V}o_2$ max can be a limiting factor for individual capacity to do prolonged muscular work. Though determination of $\dot{V}o_2$ max by a direct method would be ideal it may not be a practical proposition. Then again considering that there is a difference of a few hundred ml/min (4), the use of a indirect method especially as a screening test is fully justified in the present study.

The data from this study may help in the establishment of norms in assessing physical fitness prior to participating in training programmes and vigorous sports. Further study in this field is indicated to confirm the higher value of $\dot{V}o_2$ max obtained for 18 years category as compared to 19 years, which otherwise is difficult to explain.

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