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ASSESSMENT OF CARDIOVASCULAR RESPONSE TO TREADMILL EXERCISE IN NORMAL HEALTHY INDIAN ADOLESCENTS

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The study aims to assess the cardiovascular response to treadmill exercise test in healthy Indian adolescents. A group of 50 healthy adolescents took part in the study. Cardiovascular response was assessed by using treadmill exercise test as per Bruce protocol. Pulse rate, blood pressure and ECG were recorded before, during and after undertaking the treadmill test. Mean age and body mass index (BMI) were 18.7±0.51 yrs. and 21.4±3.44 kg/m^2 respectively. Karl Pearson Correlation analysis showed highly significant negative correlation between BMI and exercise time ($r = –0.598$, $P<0.001$) and between resting DBP and Exercise Time ($r = –0.424$, $P<0.002$). While BMI and DBP showed highly significant positive correlation ($r = 0.463$, $P<0.001$). During exercise pulse and SBP rose and DBP fell. SBP rose from mean 122 to 175 (rise by 53 mm of Hg) and DBP fell from mean 78 to 65 (fall by 13 mm of Hg). One min recovery pulse was 156 indicating 22% fall from target heart rate. All the parameters returned to near resting value at 6 min recovery. In 30% students DBP showed exaggerated response i.e. rise during exercise. These students had more BMI and higher resting DBP as compared to other students, which could be the reason for exaggerated response in these participants. In ECG there were no significant ST/T changes during exercise or recovery period. This study provides normal data for small sample of healthy Indian adolescents when subjected to treadmill exercise test.

adolescents body mass index
treadmill exercise test heart rate systolic blood pressure
diastolic blood pressure ECG

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INTRODUCTION

Dynamic exercise is often used to evaluate the functions of cardiovascular system, and the treadmill test is a commonly used dynamic exercise protocol. The study aims to assess the cardiovascular response to treadmill exercise in healthy adolescents, and create normal reference values of exercise testing in Indian adolescents. SBP, DBP and ECG changes during exercise and recovery period were studied. We also aimed to find out correlation between anthropometric factors and exercise response.

Treadmill test is a commonly used well established and diagnostic as well as prognostic tool for assessing patients with suspected or known coronary artery disease (1). Treadmill is a reliable, easily repeatable, noninvasive test and does not cause any harm to the patients. It helps to evaluate the level of functional capacity of cardio respiratory system in healthy individuals as well. In young population it can be used as screening test for participation in vocational, leisure and sport activities and also to observe the arterial pressure response to exercise. Arterial BP is used to indirectly assess heart's inotropic response to physical exertion associated with the level of exercise tolerance.(2) The hypertensive response of BP to physical exertion in normotensive individuals may be predictive of development of arterial hypertension later in future life, which can be prevented by changes in food habits, lifestyles etc. Hypertension is a key risk factor for cardiovascular disease morbidity and mortality. Several studies have examined the role of BP response to exercise as a risk factor for the development of hypertension (3).

During period of transition from adolescents to adulthood many structural, hormonal, and biochemical changes in body physiology take place. Hence it is necessary to establish reference values for this population, for the classification of physical fitness, and also for advice on exercise. It has been observed recently that maximal exercise capacity in children has deteriorated during past 20 yrs. BMI was found to correlate negatively and intense sports participation positively, with exercise time (4). It is documented that ethnic differences are important determinants of cardiopulmonary function. Applying adequate reference values is essential for the correct interpretation of the data from functional tests.

In view of these observations aim of the present study was to determine reference values for contemporary healthy Indian adolescents by using Bruce treadmill protocol.

MATERIALS AND METHODS

Selection of participants

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Tread mill test

$_2$ administration, Emergency drugs, Ambu bag, Defibrillator etc. were kept ready. Participants were asked to lie down in supine position for at least 10 min before the exercise. Resting heart rate, SBP and DBP were recorded. For recording BP manual mercury sphygmomanometer was used. After skin preparation, ten disposable silver chloride electrodes were attached at proper position for continuous monitoring of electrocardiogram (ECG). Resting 12 lead ECG was recorded. Treadmill exercise was explained and demonstrated to the participant, especially regarding most comfortable gait and safety devices. They were instructed not to tightly hold the side rails to avoid isometric element. Heart rate and ECG were recorded continuously during exercise. SBP and DBP were measured at the end of every stage manually by mercury manometer. End point of the test was achievement of target heart rate (220 - age in yrs = 200/min)(1) or the test was planned

Statistical methods

$_2$ respectively. Mean resting SBP and DBP was 122.68±8.34 and 78.6±6.2 mm of Hg respectively. Average time of exercise was 9.7±2.04 min.

Table I shows Karl Pearson Correlation regression analysis. It showed highly significant correlation between BMI and resting BP. There was negative correlation between BMI and exercise time ($r = -0.598$, $P<0.001$) and between resting DBP and exercise time ($r = -0.424$, $P<0.002$).

Cardiovascular responses in terms of changes in Pulse, SBP and DBP at rest, at

TABLE I : Correlation of BMI with Cardio-vascular parameters of the subjects.

Parameters	*r*	*P*
SBP	0.433	0.002**
DBP	0.463	0.001**
Exercise time	–0.598	0.000**
DBP and Exercise time	–0.424	0.002**

*Correlation is significant at 0.05 level (two-tailed)
**Correlation is significant at 0.01 level (two-tailed)

TABLE III : Groups according to decreased and increased DBP response during TMT.

	A (Fall in DBP) Mean±SD (n=35)	*B (Rise in DBP) Mean±SD (n=15)*	*P Value*
BMI	20.24±2.3	23.06±2.05	0.00**
DBP rest	77.43±5.95	81.33±6.03	0.04*
Ex. time	10.25±1.8	8.57±2.12	0.01*
DBP THR	70.51±6.35	88.53±6.69	0.00**
1 min Recovery HR	152±9.69	165.2±9.43	0.00**
% Recovery in HR	24±4.85	17.36±4.7	0.00**
DBP 6 min Recovery	70.51±6.35	81.03±5.93	0.01*

THR – Target Heart Rate.

BMI – Body mass index; HR-Heart Rate; DBP-Diastolic Blood Pressure.

Unpaired Student's t test: Significance was tested at P<0.05 (*) and P<0.001 (**).

TABLE II : Mean HR, SBP, DBP at rest, at different stages of TMT and during recovery period.

	N	*HR*	*SBP*	*DBP*
At Rest	50	84±11.5	122.68±8.34	78.6±6.18
Ex. Stage				
1	50	132.46±21.89	142.6±15.33	78.48±7.51
2	50	155.98±22.15	154.32±14.13	77.92±8.98
3	48	177.47±20.58	164.95±14.77	78.66±9.14
4	36	200.16±7.30	167.38±11.20	73.05±9.50
5	2	200	175.00±7.07	65±7.0
Recovery				
1 min	50	155.98±11.33		
3 min	50	114.68±17.27	149.36±14.36	80.80±5.36
6 min	50	105.16±13.55	130.00±11.68	78.20±5.83

BMI – Body mass index; HR – Heart Rate; DBP – Diastolic Blood Pressure; SBP – Systolic Blood Pressure.

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After interrogation it was discovered that one of them did not have a sound sleep in night due to some family problems. In study conducted by Bhave et al in 1989 (5), 32% ie 8 out of 25 adolescents could go up to fifth stage. In study by Sung et al in 1999 (6), 58% reached 5th stage and 10 % could reach 6th stage. Mean ex. time was more i.e. 15.7±2.2 min in adolescent boys as compared to 9.7±2 in ours indicating less endurance. This difference could be due to recent changes in lifestyle, lack of physical exercise and change in feeding habits. Sung et al (6), Becker et al (2) reported positive correlation in BP and ht, wt. This study also showed that resting SBP and DBP significantly correlated with BMI.

The arterial pressure response to exercise in children and adolescents has been the focus of several studies in many countries. It has been confirmed that there are differences when diverse populations are compared. Some of these differences are attributed to the different methodologies and test protocols used. In most studies, children and adolescents were evaluated by means of multistage protocols, particularly the treadmill test developed by Bruce. Our findings regarding blood pressure were similar to those reported in medical

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