Research Article

Study of relationship between cardiorespiratory fitness and blood pressure in young obese individuals

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Abstract

Introduction: The prevalence of hypertension amongst children and young adults in India is increasing nowadays, increased adiposity is considered to be one of the major factors implicated in the pathogenesis of hypertension and is associated with low cardiorespiratory fitness levels. **Aims and Objective:** To study the relationship between cardiorespiratory fitness and blood pressure among young obese individuals. **Material and Methods:** Sixty young obese individuals in the age group of 20 to 25 years were included in this study group. Body mass index was measured as weight in kilograms divided by height in meters square. Resting blood pressure was recorded. Cardio respiratory fitness in terms of VO_2max was predicted by standard Bruce Treadmill protocol. Pearson's correlation test was used to find out correlation between VO_2max and blood pressure. **Results:** VO_2max showed significant negative correlationship with the blood pressure in both male and female subjects. An important finding was that there was a gender difference in the association of VO_2max with blood pressure profile. While in females, VO_2max showed a significant negative correlationship with DBP, in males, it showed a significant negative correlationship with PP. Regarding the correlationship with SBP and MAP, VO_2max showed significant correlationship in both gender, but again a stronger correlationship was found amongst females as compared to male subjects. **Conclusion:** It may be concluded that a correlation exists between cardio respiratory fitness and blood pressure. In order to have higher fitness profile and to avoid cardiovascular complications, young adults should take care of their food habits and physical activity to maintain optimal body weight.

Keywords: Blood Pressure, Cardiorespiratory fitness, Obesity, VO_2max.

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INTRODUCTION

The prevalence of hypertension amongst children and young adults in India is increasing nowadays, increased adiposity is considered to be one of the major factors implicated in the pathogenesis of hypertension[1-4]. Obesity in young age is due to lack of physical activity and poor eating habits. In India, the prevalence of overweight state and obesity is increasing in children and young adults which is reflected by various studies[5]. Studies have shown that obese individuals have reduced cardiorespiratory fitness (CRF) and are at increased risk of cardiovascular diseases[6]. Cardiorespiratory fitness is a health-related component of physical fitness defined as the ability of the circulatory and respiratory systems to supply oxygen during sustained physical activity[7]. Maximal oxygen uptake (VO_2max) is the maximum capacity to transport and utilize oxygen during incremental exercise. It is also known as aerobic capacity, which reflects physical fitness of a person[8]. Those individuals who are more fit have higher VO_2max and can exercise more intensely and longer than those who are not as well conditioned. As VO_2max is a very good

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indicator of cardio respiratory fitness[9-13] , it was used in our study to assess the cardiorespiratory fitness of young individuals. Although many studies from India have reported an increase in prevalence of Hypertension amongst children and young adults and hypothesized sedentary lifestyle to be the probable culprit along with overweight and obesity, very few studies have reported the effect of physical fitness on the blood pressure level amongst the young individuals. Hence the current study was conducted to determine how cardiorespiratory fitness affects the blood pressure of young obese individuals.

METHODOLOGY

Selection of participants

Sixty obese medical students (30 male and 30 female) of Jagadguru Sri Shivarathreeshwara Medical College aged between 20 and 25 years were selected after screening for age, history of hypertension, cardiac or pulmonary diseases, smoking and alcohol consumption. The Ethical committee of the JSS University had approved the study and each participant provided informed consent. All the experiments were performed in the research laboratory of Physiology department, JSS medical college, Mysore.

The following Parameters were studied,

Body weight of the subject was measured (to the nearest 0.5kg) with the subject standing motionless on the weighing scale with feet about 15cm apart and weight equally distributed on each leg. Subjects were instructed to wear minimum outerwear (as culturally appropriate) and no foot wear while their weight was measured. The weighing machine was calibrated with a standard weight of 500 grams and necessary corrections were made from time to time.

Height was measured (to the nearest 0.005meter) with the subject in an erect position against a vertical surface, with the head positioned so that the top of the external auditory meatus was in level with the inferior margin of the bony orbit.

Body mass index was calculated for each subject using Quetelets formula:

$$Body\ Mass\ Index = \frac{Weight\ in\ Kilograms}{Sqaure\ of\ Height\ in\ Meters}\ (Quetelets\ formula)$$

Blood pressure (BP) was recorded in both the groups. Mercury sphygmomanometer was used to measure the blood pressure. Two measurements of blood pressure using standard technique were done on each study participant. Both blood pressure measurements were obtained after the subject rested for atleast 5 minutes in a seated position. All blood pressure measurements were made on left arm of each subject, using a cuff of appropriate size, at the level of the heart. The cuff will be slowly released at the rate of about 2mm per second and the readings recorded to the nearest 2mm Hg. The first (appearance) and the fifth (disappearance) Korotkoff sounds were recorded as Systolic (SBP) and Diastolic blood pressure (DBP) respectively. Mean arterial pressure (MAP) was calculated using the formula

MAP =DBP+1/3 PP in mm Hg

Where PP is pulse pressure, which is the difference of SBP and DBP. The average of two readings of SBP and DBP was taken as the blood pressure of each participant.In case the two readings differed by over 10 mm of Hg, a third reading was obtained and the three measurements were averaged.

Estimation of VO_2max using Bruce treadmill test.

The standard Bruce protocol has been widely used and found to be reliable and valid in estimating maximal oxygen uptake using predicted equations [8,9]. The exercise was performed in a well-ventilated room. Participants were instructed not to consume beverages and not to eat a heavy meal or participate in any vigorous activity 24 hours before the test. They were properly acquainted with the experimental protocol. A trained physician was present during the study and all the necessary resuscitation equipment was kept ready to deal with the complications if any occurred. It was first demonstrated to the subjects how to walk on the moving belt. Then they were asked to step on and start walking on the slowly moving belt. Once the subject adjusted to walking on the treadmill, the exercise was started as per the standard Bruce protocol. The treadmill was started at 2.74 km/hr (1.7 mph) and at a gradient (or incline) of 10%. At every three minute intervals the speed and inclination was increased as per the protocol used. Whenever the speed was increased, subjects were notified about the same and were asked to report if they had any problem. ECG was monitored continuously by paying due attention to the changes that may warrant premature termination of the test. The end point of exercise test was complete exhaustion of the subjects or attainment of 90% of the predicted maximum heart rate (220-age in years). The total time of exercise test (T) was noted in fraction of a minute.

Predicted equations for estimating VO_2max:

For Men $VO_2max = 14.76 - (1.379\times T) + (0.451\times T^2) - (0.012\times T^3)$

For Women $VO_2max = 4.38 \times T - 3.9$

Where 'T' is Test time in fraction of minute.

STATISTICAL ANALYSIS

The results were expressed as mean ± standard deviation (SD). A p value of <0.05 was considered statistically significant. Statistical analysis was performed using the statistical package for social and sciences. Pearson correlation was applied to correlate between the parameters.

RESULTS

VO_2max showed significant negative correlationship with the systolic blood pressure , pulse pressure and mean arterial blood pressure in males(Table 1), where as in females it showed significant negative correlationship with the systolic blood pressure , diastolic blood pressure and mean arterial blood pressure (Table 2).

Table 1: Correlation of VO_2max with Blood Pressure in males

Study variables	Males	
	r	p
SBP	-0.992*	0.001
DBP	-0.471	0.076
PP	-0.955**	0.001
MAP	-0.859**	0.001

Note: Pearson's correlation test

Table 2: Correlation of VO_2max with Blood Pressure in females

Study variables	Females	
	r	p
SBP	-0.529*	0.043
DBP	-0.783**	0.001
PP	-0.038	0.894
MAP	-0.776**	0.001

Note: Pearson's correlation test

DISCUSSION

VO_2max is a very good indicator of cardio respiratory fitness/cardiovascular and exercise tolerance for everyday activities which are largely aerobic for the general population. Research has indicated the importance of exercise in reducing the risk of cardiovascular diseases, through reduction of blood lipids, body fat, and blood pressure, improvement in myocardial function[14]. Obesity is proven risk factor for systemic hypertension. Several pathophysiological mechanisms may contribute to the higher blood pressure values observed in obese individuals. First, sympathetic activation associated with obesity and molecules released by hypertrophied fat cells may promote the formation of angiotensin and aldosterone, which have direct vasopressor and antinatriuretic effects, thereby increasing blood pressure. Second, a local renin angiotensinogen system was identified in human adipose tissue, where it may act independently from the plasma renin-angiotensinogen system. Third, obesity, particularly abdominal obesity, is characterized by an abnormal production of proinflammatory cytokines, arising from expanded abdominal fat and related perivascular tissues, which may have an influence on endothelial cells and vascular modulation. Obesity-associated insulin resistance has also been related to hypertension and related metabolic abnormalities[15]. Cardiorespiratory fitness showed a significant association with blood pressure across both genders. But, the probable mechanisms through which cardiorespiratory fitness affect the blood pressure seem to vary according to gender. In male subjects, cardiorespiratory fitness showed a significant negative correlationship with pulse pressure suggesting that physical fitness may be affecting the vascular distensibilty amongst males. On the other hand, in females, cardiorespiratory fitness showed a significant negative correlationship with diastolic blood pressure and an insignificant correlationship with pulse pressure suggesting that, in females, physical fitness may be affecting the sympathetic vascular activity. The probable reason for these gender differences is the presence of the male sex hormone testosterone in males and female sex hormone estrogen in females. Testosterone predisposes the male vasculature to endothelial dysfunction and atherosclerosis while Estrogen protects the female vasculature from atherosclerosis and makes the blood vessels more distensible[16]. This view is supported by the findings of Ahimastos *et al* who conducted a study to determine the gender differences in large artery stiffness in pre and post puberty stages[17]. The study showed that prepubertal males and females did not differ in body size, cardiac output, or heart rate. It also showed that the prepubertal females had stiffer large arteries and higher pulse pressure than age-matched males. However, on the other side, postpubertal males were taller and heavier and had a greater cardiac output and lower heart rate compared with similarly aged females. In relation to pubertal status, females developed more distensible large arteries post puberty whereas males developed stiffer large vessels. The effects of Testosterone on vascular function have also been reported by Herman *et al*. They found that the dilatation of brachial artery in response to increase blood flow (endothelial dependent dilatation) was higher amongst individuals who were having low levels of serum testosterone. On multivariate analysis, increased endothelium-dependent dilatation was significantly associated with low serum testosterone levels. This finding suggested that testosterone causes endothelial dysfunction[18]. We have also reported similar gender differences in the association of cardiorespiratory fitness with pulse pressure. There was significant positive correlationship with pulse pressure amongst males and an insignificant correlationship with the pulse pressure amongst females. Based on our findings, we believe that longitudinal and/or intervention studies with specific measurements of cardiorespiratory fitness and adiposity are required to properly investigate the risk factors for systemic hypertension. Although it might be reasonable to believe that both cardiorespiratory fitness and adiposity might be 2 important risk factors that independently contribute to the development of systemic hypertension, longitudinal and intervention studies are required to investigate the extent to which the relationship between fitness and systemic hypertension is explained by adiposity. Identifying the risk factors for systemic hypertension and the extent to which these risk factors contribute to blood pressure are the keys in the development of successful blood pressure managing strategies.

CONCLUSION

It may be concluded that correlation exists between cardio respiratory fitness and blood pressure among obese individuals and those individuals with lower cardio respiratory fitness are at increased risk of development of systemic hypertension and other complications related to hypertension in later age. Hence its advisable for those individuals to modify their life style and to maintain optimal body weight.

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