Original Research Paper

International Physiology
Vol. 5 No. 2, July - December 2017
DOI: https://dx.doi.org/10.21088/ip.2347.1506.5217.3

Study of Heart Rate and Blood Pressure Response to Isometric Leg Press Exercise Test in Obese Young Male Adults

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Abstract

Background and Objectives: Assessment of Cardiovascular sympathetic activity in obese and Normal young adults by recording Heart rate and blood pressure. The study was done to assess the effect of isometric Leg press exercise test on Heart rate Blood pressure (SBP & DBP) levels in obese and normal young adults. *Methods:* The study was carried out on 80 medical students with in age group of 18-22 years, divided in to two groups, 40 Obese (BMI >25kg/m2) and 40 Normal healthy adults (BMI 18.5-22.5kg/m2). Baseline ECG was taken for 5 minutes in lead II using power lab multichannel polygraph instrument to record Heart rate in both the groups. Baseline Blood pressure was recorded in both of them. They were asked to perform isometric leg press exercise at 40% of their maximal voluntary contraction using Back leg lift dynamometer till the point of fatigue. Immediately after exercise test Heart rate and Blood pressure were measured to compare the response. *Results:* Baseline recording showed statistically significant higher Heart rate and Blood pressure level in obese group when compared to normal group ($p<0.05$). There was significant difference in Heart rate and BP between the two groups. The response to exercise test varied among the groups. The normal group showed significant rise in Heart rate and blood pressure ($p<0.05$) than obese group. *Conclusion:* From this study we conclude that, there is a positive association between obesity and blood pressure level. There is autonomicdys function with increased sympathetic activity, which is an important determinant of elevated blood pressure in obesity. Also higher value of resting heart rate in obese individuals is due to attenuated parasympathetic vagal tone in them. Sympathetic system could be targeted in the treatment of obesity associated hypertension.

Keywords: Obesity; Isometric Leg Press Exercise Test; Blood Pressure.

Introduction

Maintaining an adequate body weight is a major determinant of the survival and fitness of mammals including human beings. It is important to emphasize that many individuals, whether lean or obese maintain their body weight within small limits during long periods of time. Inhuman adults, there are mechanisms that tend to maintain a balance between energy intake and energy expenditure. There is preponderant evidence for the existence of control of adipose tissue mass with signals, which act on hypothalamic receptors with effect on the autonomic nervous system [1]. Obesity is becoming a global condition in both children and adults. It is an abnormal or excessive fat accumulation which occurs due to increased consumption of calories and/ or decreased physical activity. It is associated with number of cardiovascular diseases such as, Hypertension, Sleep apnea and Coronary heart disease [2]. Obesity has been proposed as a risk factor for hypertension and sudden death. In India prevalence of obesity is increasing in children and adolescents as reflected in various studies [3]. Exercise is an important activity in daily life. Depending on the type of physical exercise carried out, its influence on heart rate and blood pressure response varies.

As per previous studies, isometric leg press exercise testing provides much more clinical information about sympathetic activity, but neglected because of potential risk. It causesless risk to the subjects if monitored properly. Following isometric exercise test protocol, in normal healthy subjects there will be increase in Heart rate (HR), Systolic blood pressure (SBP), Diastolic blood pressure (DBP) and Mean arterial pressure (MAP). Blood pressure is regulated by the autonomic nervous system [4]. Obesity is associated with increased sympathetic activity and is the leading risk factor for development

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Received on: November 01, 2017 **Accepted on:** December 08, 2017

of hypertension [5]. There is a significant relation between obesity and hypertension. It is important to know that the effect of exercise training might decrease body mass index which could be reflected with improvement in their cardio respiratory fitness. Data on exercise and its effects on the cardiovascular system and long-term survival are still limited in spite of vast knowledge on exercise. The responsibility for conducting research lies with government, private health agencies, universities, and medical colleges. Cardiovascular response to physical exercise is influenced by many factors such as Age, sex, type of activity carried on prior training status. Training, in particular is considered to reduce both adrenergic and pressure response to exercise. However, not much information is available on sympathetic cardiovascular functions in obese young adults. Hence, the present study is under taken to assess and compare the cardiovascular responses to isometric Leg press exercise test in obese and normal weight medical students. Present study is conducted to assessment of cardiovascular sympathetic activity in obese and normal young adults by recording Heart rate and Blood pressure.

Materials and Methods

Healthy young adults in the age group of 18-22 years were selected. The young adults were screened for their age, history of hypertension, history of any cardiac or pulmonary disease, smoking and alcohol. Clinical examination was done on all the subjects to rule out systemic disorders. The height and weight of each participant was recorded. Body mass index was calculated by the formula [6].

Body mass index = Weight in kilograms/ Height in meters square

Method of selection of Subgroups - 40 young adults in the age group of 18-22years with BMI >25kg/m2 Constitutes the Obese group (OG). 40 age and sex matched medical young adults with BMI 18.5-22.5kg/ m^2 constitutes the control group (CG). This sample size was estimated enough to detect clinically relevant difference.

Obese Group

Inclusion Criteria: BMI (Body Mass Index) >25kg/m^2

Normotensive, Non-smokers, Non-alcoholic, Non-tobacco chewers.

Exclusion Criteria: BMI < 25kg/m^2, Age above 22 years or below 18 years, Hypertensive subjects, Smokers, Alcoholics, Tobacco chewers, History of acute / chronic illness

Normal Group

Inclusion Criteria: BMI 18.5-22.5 kg/m^2, Age group 18-22 years, Normotensives, Non-smokers, Non alcoholics, Non Tobacco chewers.

Exclusion Criteria: BMI < 18.5 or >22.5 kg/m^2, Age group above 22 years or below 18 years, Hypertensive subject, Smokers, Alcoholics, Tobacco chewers, History of acute / chronic illness.

Method of Data Collection: The Exercise testing was performed in the normal room temperature with bright light. The subjects were made to relax for 5 minutes before recordings. BP was recorded by Mercury Sphygmomanometer and Stethoscope. HR was recorded by using Power lab ECG instrument. Isometric exercise was performed by Back leg lift dynamometer. The subjects were instructed not to hold their breath during the exercise test to avoid performing the Valsalva manoeuver. The parameters heart rate, Blood pressure, (systolic and diastolic), Maximum Voluntary Contraction were recorded.

Statistical Analysis: The values expressed in mean and standard deviation of all the cardiovascular parameters -Heart Rate, Systolic Blood Pressure, Diastolic Blood Pressure for both groups. Independent sample 't' test procedure compares means of two groups of subjects. Students 't' test was applied using SPSS for windows (version18) at 5% level of significance to test the significance of changes in cardiovascular parameters stated above. The 'p' value less than 0.05 ($p<0.05$) was considered statistically significant.

Results

Before Exercise Test

The present study included 80 subjects (40 obese and 40 normal weight group) in the age group of 18-22 years. The characteristics of the two groups are shown in Table 1. The mean value of body mass index was higher in obese group when compared to normal group as shown in Table 1. The mean value of baseline heart rate (HR) was higher in obese group when compared to normal group as shown in Table 2.

The mean value of systolic blood pressure (SPB) and diastolic blood pressure (DBP) and mean arterial pressure of obese group was more when compared to

normal group before exercise test as shown in Table 3. These differences were statistically significant. There was a positive association between body mass index and systolic and diastolic blood pressure.

After Exercise Test

The Mean of heart rate, response to isometric leg press exercise test in obese group and normal group were statistically significant. The increase in heart rate after isometric Leg press exercise test was lower in obese group when compared to normal group (Table 2). The increase in systolic blood pressure and diastolic blood pressure and mean arterial pressure to isometric leg press exercise test was lower in obese group when compared to normal group (Table 3). The difference was statistically significant. After 5 minutes of exercise test the systolic and diastolic blood pressure returned to pre-exercise test (Table 4). This indicates increase in heart rate and blood pressure was due to exercise test in both groups.

Table 1: Characteristics of the two groups

	Obese	Normal weight
Number of Subjects	40	40
Age	18±1.07	18.43±0.63
Sex	Male	Male
BMI	29.37±3.25Kg/m^2	20.64±2.12 kg/m^2

*'p value<0.05, statistically significant

Tabl 2: Mean ± S.D. values of Heart rate pre and post exercise test in obese and normal group

	Groups	Mean ± S.D.	P values
Heart rate (pre)	Obese	82.2±2.84	0.000*
	Normal	76.7±2.90	
Heart rate (post)	Obese	83.3±2.83	0.029*
	Normal	77.72±2.96	

Table 3: Mean SBP, DBP pre and post exercise test and 5min after exercise test in obese and normal weight group

	Group	Mean ± S.D.	P value
SBP (pre)	Obese	126.1±4.02	0.000*
	Normal	115.5±5.61	
DBP (pre)	Obese	80.00±3.38	0.000*
	Normal	70.30±2.33	
SBP (post)	Obese	131.8±3.78	0.000*
	Normal	123.3±5.77	
DBP (post)	Obese	86.2±2.78	0.046*
	Normal	77.90±2.59	
MAP(pre)	Obese	95.36±2.46	0.000*
	Normal	85.36±2.67	
MAP (post)	Obese	101.4±2.40	0.000*
	Normal	93.03±2.54	
SBP (after 5 min)	Obese	124.80±8.71	0.000*
	Normal	113.06±9.68	
DBP (after 5 min)	Obese	79.33±4.85	0.00*
	Normal	69.33±5.64	

*p value<0.05, statistically significant

Discussion

The present study reveals, the Mean value of body mass index (BMI) of obese group (OG) was significantly higher when compared to normal group. Also Mean value of Resting Heart rate was significantly higher in OG than NG. The mean values of resting systolic blood pressure, diastolic blood pressure were significantly higher in obese group when compared to normal group. The higher values of Resting SBP, DBP had a significant positive correlation with BMI. The results of our study are consistent with K. Sri Nageshwari et al [3], who have observed increased blood pressure level in obese children. In obesity, increased cardiac output

observed with weight gain is due to extra blood flow required for the extra adipose tissue. Sustained and prolonged hemodynamic burden is required to induce structural changes in left ventricle as in case of long standing obesity [2]. Factors linking obesity to increase in HR and BP includes the increment in total blood volume and cardiac output that is caused by increased metabolic demands induced by excess body weight , increased sympathetic activity, endothelial dysfunction, insulin resistance and substances released from adipocytes (IL- 6, TNF.)

Characteristically obese subjects have increased sympathetic nerve activity, increased insulin levels, increased activity of Renin Angiotensin aldosterone system [7]. It can be hypothesized that higher Resting SBP,DBP in obese could be due to higher vasoconstrictor tone and/or increase in cardiac output due to increased load on heart, as a consequence of increased body mass index. Part of increased cardiac output observed with weight gain is due to additional blood flow required for the extra adipose tissue. Sympathetic activation contributes to higher blood pressure level in obese group and Higher Resting Heart rate could be due to attenuation of parasympathetic vagal tone in obese individuals. Sympathetic activation increases blood pressure and causes sodium and water retention in obesity. Activation of Renin-angiotensin- aldosterone axis causes retention of the fluid leading to increased blood volume. Renal sympathetic nerve mediates sodium retention and hypertension in obesity.

Mechanism of sympathetic activation and high blood pressure levels in obesity:

1. Renal afferent nerves, stimulated by increased intra renal pressure and subsequent activation of renal mechanoreceptors, leading to renin-angiotensin- aldosterone system activation.
2. Hyperinsulinemia,
3. Fatty acids,
4. Angiotensin II,
5. Hyperleptinemia

The discovery of leptin represents the major breakthrough in obesity research. Leptin is an adipocyte derived hormone that acts on hypothalamus to regulate appetite and energy expenditure. Now it is clear that white fat depots are not inert lumps but are actually endocrine tissues that secrete not only Leptin, but also other hormones like adipokines that affect fat metabolism. In addition, to these advances, there has also been a revolution in our understanding of neuroendocrine mechanisms regulating appetite, metabolism, and adiposity since the discovery of leptin just 15 years ago. If these advances soon translate into safe and effective pharmacological treatment of obesity, this would also greatly impact the management of obesity induced hypertension [5].

Evaluation of circulatory changes during sustained isometric muscle contractions is a useful method to assess cardiac function. During isometric exercise test, the literature mentions, in a normal healthy person sympathetic system gets activated leading to, activation of cardiac sympathetic fibres causes increase in heart rate dependent increase in cardiac output and blood pressure and activation of peripheral sympathetic fibres to blood vessels causing, vasoconstriction and resultant increase in total peripheral resistance.

Obese group had statistically significant increased baseline HR, SBP, DBP, before application of any type of stimulus due to increased vasoconstrictor tone at rest. Following isometric leg press exercise test, the obese group showed lower increase in Blood pressure response, when compared to normal group. This difference was statistically significant. There was significant difference in heart rate response to isometric leg press exercise test between the two groups.

The Obese group revealed a decreased response to isometric leg press exercise test indicating presence of instability/dysfunction of cardiac sympathetic activity [3]. The lower heart rate and blood pressure response in obese group is majorly attributed to lower cardiac sympathetic activation or to a lower increase in peripheral vascular response to maneuvers activating sympathetic system [8]. The derangements in sympathetic cardiovascular function in the form of elevated baseline HR, SBP, DBP and decrease in response to back –leg lift dynamometer exercise test in obese group points towards autonomic instability/ dysfunction. Thus, in obese ANS is affected which may be the cause of various cardiovascular complications.

The single most important role of Sympathetic nervous system (SNS) is maintenance of adequate blood pressure to maintain the functioning of vital organs. This is achieved principally by sympathetic control of cardiac output and blood vessels. The importance of SNS in the control of cardiovascular system should not be overlooked, as any nonspecific stimulation or antagonism of SNS intended to produce metabolic effects will also have significant cardiovascular effects that could be undesirable.

Obesity is recognized as a major, worldwide, health problem. Excess weight is a major cause of increased

blood pressure in most patients with essential hypertension. Being overweight or obese increases the risk for cardiovascular disease through multiple mechanisms, including diabetes, dyslipidemia, atherosclerosis, renal disease, and hypertension. From the present study we conclude that, there is a positive association between blood pressure level, and obesity.

Autonomic instability, in the form of enhanced basal peripheral vasoconstrictor tone, decreased cardiac sympathetic activation following exercise make the obese subjects more prone to cardiovascular diseases. Obese young adults with higher blood pressure level are at increased risk of cardiac diseases and hypertension in later part of their life. Sympathetic system could be targeted in the treatment of obesity associated hypertension.

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