

## Comparative Study of Sympathetic Cardiovascular Tests in Obese and Non – Obese Adults

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### Original Research Article

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#### Article History

Received: 17.10.2017

Accepted: 23.10.2017

Published: 30.10.2017



**Abstract:** The blood pressure responses to cold pressor and sustained handgrip were studied in cases and controls. The cardiovascular sympathetic functional status can be assessed by using these simple tests; effective for diagnosis of early cardiovascular autonomic dysfunction. The cardiovascular sympathetic function tests have been conducted in 30 cases of obese adults and 30 controls i.e, non-obese adults aged between 30-50 years, including both sexes. Cases showed statistically significant decreased response of systolic and diastolic blood pressure to cold pressor and to sustained handgrip. The responses in cases were significantly correlated to Body Mass Index (BMI). Finally signifying that autonomic dysfunction occurs in Obesity.

**Keywords:** Obesity, Sympathetic Nervous System, Blood pressure, cold pressor, Hand grip

### INTRODUCTION

Obesity is defined as per WHO, an excessive accumulation of fat in the body that causes a generalized increase in body mass[1]. Obesity occurs when caloric intake exceeds energy expenditure and the excess calories are accumulated in adipose tissue[2]. Therefore obesity is suggested to be an imbalance between energy intake and expenditure resulting from complex interaction of genetic, physiological, behavioral and environmental factors[3]. Obesity is a leading preventable cause of death worldwide and it is one of the most serious public health problems of the 21st century[4].

Before 20th century, obesity was rare; In 1997 the WHO formally recognized obesity as a global epidemic. As of 2005 the WHO estimates that at least 400 million adults are Obese. The rate of Obesity also increases with age at least up to 50 or 60years old[5]. The most commonly used indicator of general adiposity is “Body Mass Index (BMI)” measured in Kg/m<sup>2</sup>. A BMI of 20 – 25 Kg/m<sup>2</sup> is considered as normal. If it is in between 25 – 29.9 Kg/m<sup>2</sup> is considered as overweight. If it is more than 30Kg/m<sup>2</sup> then it is referred as “obese” [6].

Obesity is associated with a variety of medical disorders associated with cardiovascular dysfunction [7]. Relationship between obesity and cardiovascular disease is well reorganized [8]. The sympathetic nervous system is an important contributor to the regulation of one and other the cardiovascular system

and energy expenditure, is extensively simulated to play an important role in the pathophysiology of obesity [9]. Recent studies shows the past two decades have correlated sympathetic nervous system activity in normal-weight and obese individuals [10]. These studies include hypertension, myocardial infarction, congestive heart failure and vascular thrombosis. It is mainly because of Autonomic dysfunction where the sympathetic activity is decreased and parasympathetic activity is increased.

### METHODOLOGY

Thirty cases of Obese participants and thirty non obese age matched controls, including both males and females, were assessed for cardiovascular sympathetic functional status after obtaining written and informed consent. The study was approved by institutional ethics committee. The

following criteria were followed while selecting the patients as cases: The individuals having BMI (Body mass index) more than 30Kg/m<sup>2</sup>, Age between 20-50 years and not suffering from any other disease or complications.

All the healthy subjects (controls) and Obese participants (cases) were subjected to general and physical examination. Cardiovascular sympathetic function tests were carried out in the morning, after familiarizing the subjects with the testing procedures.

The following tests were performed to assess the cardiovascular sympathetic functional status: Blood pressure response to cold pressor and Blood pressure response to sustained handgrip.

**Blood pressure response to sustained handgrip**

The subject was then asked to the dynamometer with the left hand to determine the maximum voluntary contraction. The handgrip was then maintained steadily at 30% of that maximum voluntary contraction for 1 minute. Again blood pressure was measured with the cuff of the sphygmomanometer on the right arm (non exercising arm) by auscultator method, at the end of 1 minute after the onset of handgrip. The difference in the blood pressure was noted.

**Blood pressure response to cold presser test**

The subject was asked to sit comfortably on the chair. Subject was instructed regarding the test and the systolic and diastolic blood pressure was measured from the right arm with the help of sphygmomanometer by auscultatory method. Subject was asked to submerge one of his upper limbs in cold water for 60 seconds. Blood pressure was recorded at the end of 60 seconds of submersion of the limb. Statistical analysis was done by using a test of standard error of difference between two means (z-test).

**RESULTS**

The results of the above tests were compared between the cases (obese) and healthy age matched controls. Values are expressed as mean ± SEM in the tables. Sympathetic activity was recorded with the subjects. Mean blood pressure was measured with a sphygmomanometer. Heart rate was measured by electrocardiography during these daytime measurements.

**Table-1: Showing Difference in SBP before and after cold pressor test in obese and non-obese adults.**

Status of obesity	Obese	Non-obese	p-value
Mean ± SD	7.93 ± 2.99	10.0 ± 2.51	0.0054

Table-1: SBP difference in cold pressor test in obese and non-obese adults. The mean SBP difference for obese is 7.93 and for non-obese is 10.0.

**Table-2: showing Difference in DBP before and after cold pressor test in obese and non-obese adults.**

Status of obesity	Obese	Non-obese	p-value
Mean ± SD	6.46 ± 3.22	8.86 ± 3.30	0.0061

Table-2: DBP difference in cold pressor test in obese and non-obese adults. The mean DBP difference for obese is 6.46 and for non-obese is 8.86. diastolic blood pressure in response to cold pressor was highly significantly (p>0.05) more in controls as compared to cases.

**Table-3: Showing Difference in SBP before and after hand grip test in obese and non-obese adults.**

Status of obesity	Obese	Non-obese	p-value
Mean ± SD	50.6 ± 3.40	9.66 ± 3.08	<0.0001***

Table 3: SBP difference in hand grip test in obese and non-obese adults. The mean SBP difference for obese is 50.6 and for non-obese is 9.66. It shows highly significant (p<0.0001) difference in blood pressure response to handgrip between two groups of cases.

**Table-4: Showing Difference in DBP before and after hand grip test in obese and non-obese adults.**

Status of obesity	Obese	Non-obese	p-value
Mean ± SD	6.13 ± 3.82	10.06 ± 3.503	0.0001***

Table-4: DBP difference in hand grip test in obese and non-obese adults. The mean DBP difference for obese is 6.133 and for non-obese is 10.06. It shows highly significant (p<0.0001) difference in blood pressure response to handgrip between two groups of cases.

**Table-5: Showing BMI distribution in obese and non-obese adults.**

Status of obesity	Obese	Non-obese	p-value
Mean ± SD	34.43 ± 3.21	23.01 ± 1.82	<0.0001****

Table-5: BMI distribution in obese and non-obese adults. The mean BMI for obese is 34.43 and for non-obese is 23.07 which shows highly significant

( $p < 0.0001$ ) correlation of the BMI with the cardiovascular sympathetic function tests in cases.

## DISCUSSION

The autonomic nervous system consists of sympathetic and parasympathetic divisions. Intact cardiac autonomic innervations are essential for normal heart rate. The sympathetic nervous system has the control on the myocardial contractility and heart rate. Cardiovascular sympathetic function tests which were carried out in this study have been extensively used in the past. They are standard, noninvasive, safe and easily reproducible.

Elenkov IJ *et al.* Under resting conditions, cardiovascular system is under the control of both the divisions of autonomic nervous system. However blood vessels are under the sympathetic tone. Under stress conditions, either physical or psychological origin there is activation of sympathetic nervous system[11]. Reddy M *et al.* The cold pressor response consists of placing the hands in cold water which acts as a painful stimulus, has been used to study the sympathetic response. In cold pressor test, an increase in the SBP by 10-20 mm of Hg and DBP by 10 mm of Hg is considered as a normal response[12]. Del Paso GA, *et al.* The afferent fibers for this response are the somatic fibers carrying the pain sensation which are stimulated by placing the hand in cold water and efferents are the sympathetic fibers. In our study no significant rise in both systolic and diastolic blood pressures were found in obese group when compared to non-obese group. In obese subjects there is no significant rise of blood pressure was found within 60 seconds and the basal blood pressure was achieved within 2 minutes. An impaired cold pressor response was found in obese subjects[13].

Florian JP. *et al.* Cold pressor test is largely related to sympathetic efferent discharge causing arteriolar vasoconstriction. Obese subjects have higher baseline DBP than controls, due to an elevated level of FFAs has been found to enhance vascular alpha-adrenergic sensitivity and consequently to increase alpha-adrenergic mediated vascular tone. These FFAs inhibit  $\text{Na}^+\text{-K}^+$  pump which raises the vascular smooth muscle tone and resistance. In obese people insulin and leptin levels are increased due to hyperglycemia and hyperlipidemia [14]. Insulin has sympathoexcitatory action; this is because it reduces glucose level in the plasma, to compensate, sympathetic system is activated which can also increase resting vascular tone. Leptin acts on hypothalamus to reduce food intake and up regulates thermogenesis through sympathetic system activation.

Thorp AA, *et al.* During cold pressor test there is impaired raise in blood pressure due to high levels of FFAs, leptin and increased insulin resistance which

cause vascular endothelial inflammation, in turn leading to increased vascular resistance to other stimuli. Chronic hyper insulinemia causes vasodilation and decreases the sensitivity of vascular muscle. Therefore on cold pressor stimulus there is no significant raise in DBP, due to impaired vascular smooth muscle responses[15].

Victor RG, *et al.* Hand grip test is isometric exercise produces a significant increase in blood pressure, a response which can be easily elicited by using sustained hand grip. In hand grip test, increase in blood pressure is due to increased sympathetic activity mediated by the alpha adrenergic receptors of the autonomic nervous system. An increase in sympathetic activity in response to handgrip is due to impulses from the Limbic cortex, motor cortex and the proprioceptors within small hand joints acting as afferent inputs into the medullary cardiac centers causing increase in blood pressure, both SBP and DBP[16]. The results showed that sustained isometric exercise results in a significant decrease in both SBP and DBP. It can be hypothesized that higher baseline blood pressure in obese group could be due to higher vasoconstrictor tone and increase in the cardiac output due to increased circulatory overload on the heart, as consequence of increase in body mass index. The lower blood pressure response to handgrip test in obese group is more likely be due to either a lower sympathetic activity or to a lower peripheral vascular resistance in response to a normal or sub normal sympathetic stimulation.

## CONCLUSION

In cold pressor test, the SBP and DBP difference values are decreased, in obese subjects when compared to Non-obese controls. In handgrip test, there are decreased SBP and DBP values in obese subjects when compared to Non-obese controls. This study reporting above mentioned tests are statistically significant.

## ACKNOWLEDGEMENTS

Cooperation with Dept of physiology, Narayana Medical college and Hospital, Chinthareddy palem, Nellore, 524003, Andhra Pradesh, India.

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