

RESEARCH ARTICLE

Effects of obesity on sympathetic nervous system

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ABSTRACT

Background: Obesity is a chronic, relapsing, neurochemical disorder controlled by the autonomic nervous system. It is an imbalance in the energy homeostasis that leads to cardiovascular conditions such as hypertension, ischemic heart disease, atherosclerosis, and stroke. The sympathetic nervous system (SNS) plays an important role in the regulation of metabolic and cardiovascular homeostasis. SNS activation is characteristic of a number of metabolic and cardiovascular diseases that occur more frequently in obese individuals. **Aims and Objective:** This study aims to assess the relationship between cardiac autonomic function (handgrip and cold pressor test [CPT]) and obesity in adults. **Materials and Methods:** This is an experimental analytical non-randomized study. Body mass index was calculated by Quetelet's index. Cardiac autonomic function tests employed were handgrip test (HGT) and CPT. **Results:** In HGT, the mean increase in systolic blood pressure (SBP) and diastolic BP (DBP) was 9.85 mmHg and 8.54 mmHg in obese and 15.88 mmHg and 14.15 mmHg in non-obese. While in CPT, the mean increase in SBP and DBP was 11.2 mmHg and 9.12 mmHg in obese and 17.00 mmHg and 14.62 mmHg in non-obese. **Conclusion:** The increase in SBP and DBP was significantly less in obese as compared to non-obese during autonomic function tests.


KEY WORDS: Obesity; Sympathetic Nervous System; Autonomic Function Test; Handgrip Test; Cold Pressor Test; Quetelet's Index

INTRODUCTION

Obesity is a condition in which excess body fat accumulates to the extent that it may have an adverse effect on health, leading to reduced life expectancy and/or increased health problems.^[1,2] It occurs due to imbalance in the energy homeostasis,^[3] controlled by the autonomic nervous system.^[3-7] Obesity is a chronic, relapsing, stigmatized, neurochemical disorder^[8,9] that irrespective of etiology leads to various cardiovascular conditions^[6,7] such as hypertension, ischemic heart disease (IHD), atherosclerosis,

stroke, and other comorbidities. The sympathetic nervous system (SNS) plays an important role in the regulation of metabolic and cardiovascular homeostasis. SNS activation is characteristic of a number of metabolic and cardiovascular diseases that occur more frequently in obese individuals.

The American Heart Association has reclassified obesity as a major, modifiable risk factor for coronary heart disease,^[8] and reversing the condition could prevent the comorbidities associated with obesity. The autonomic function of overweight and obese individuals deteriorates rapidly but there is hope since obesity is a preventable cause. The present study is done with an objective to assess relationship between cardiac autonomic function (handgrip and cold pressor test [CPT]^[9]) and obesity in adults. The aim of the study is to make one and all individuals of the community aware of the comorbidities associated with obesity and that they must adopt measures to reverse the state of obesity.

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MATERIALS AND METHODS

After obtaining the Institutional Ethics Committee clearance, this experimental analytical non-randomized study was carried out in the Department of Physiology, S.C.B. Medical College, Cuttack, from December 2013 to August 2015. By purposive sampling, 104 subjects in the age group of 20–50 years were selected. Body mass index (BMI) was calculated by Quetelet's index.^[9] On the basis of BMI, the subjects were grouped into obese (BMI ≥ 30 kg/m² but ≤ 40 kg/m²) and non-obese (BMI ≥ 19.5 kg/m² and < 30 kg/m²).

Exclusion Criteria

The following criteria were excluded from the study:

- Subjects suffering from any clinical disease likely to affect autonomic nervous system (ANS)
- Patients of malignant hypertension, diabetes, psychological diseases, head trauma, cardiac anomalies, IHD, cardiac failure, chronic obstructive lung diseases, psychological disorder, etc.
- Subjects taking medication, for example, vasodilators, α -blockers, β -blockers, barbiturates, opiates, tricyclic antidepressant (TCA) and phenothiazines that could affect autonomic functions
- Subjects with a history of smoking/alcohol/drug abuse.

After explaining the study procedures, informed consent was taken. The subjects were asked to sit comfortably for 10 min. Cardiac autonomic function tests employed were handgrip test (HGT) and CPT.

Isometric HGT^[10]

Resting blood pressure (BP) of all the subjects was measured by auscultatory method with the help of a mercury sphygmomanometer. Subjects were asked to perform isometric handgrip exercise with the help of handgrip spring dynamometer in the dominant hand to have full grip on it with maximum effort for few seconds. The whole procedure was repeated thrice with rest in between to prevent fatigue. Mean of the three readings was referred as maximal isometric tension (Tmax). Then, the subjects were asked to perform the test at 30% of Tmax for 2 min. During the test, BP was recorded from the non-exercising arm.

CPT^[11]

After recording basal BP, subject was asked to dip left arm in cold water (temp. 2–4°C) for 2 min and BP was recorded from the right arm.

Statistical analysis was done by independent samples *t*-test using SPSS version 20. $P < 0.05$ was considered statistically significant.

RESULTS

A total of 104 subjects between 20 and 50 years of age with mean age 38.5 ± 5.45 years for obese ($n = 52$) and 34.27 ± 6.10 years for non-obese ($n = 52$) were included in the study. The anthropometric measurements are described in Table 1. The mean BMI was 34.05 ± 1.5 kg/m² and 25.21 ± 3.15 kg/m² for obese and non-obese, respectively. Mean resting BP was higher in obese than in non-obese subjects. Table 2 shows that the mean resting systolic BP (SBP) was 122.62 mmHg in obese and 117.81 mmHg in non-obese. Mean resting diastolic BP (DBP) in obese was 90.35 mmHg and in non-obese was 85.88 mmHg. Table 3 describes the mean change of BP in isometric handgrip test (IHGT) was lowered in obese subjects as compared to non-obese. The mean change in SBP in obese was 9.85 mmHg and in non-obese was 15.88 mmHg. The mean change in DBP in obese was 8.54 mmHg and in non-obese was 14.15 mmHg. In CPT, the mean of change of BP in obese subjects was lower as compared to that in non-obese. The mean change in SBP in obese was 11.2 mmHg and in non-obese was 17.00 mmHg. The mean change in DBP in obese was 9.12 mmHg and in non-obese was 14.62 mmHg, respectively. It is shown in Table 4.

Table 1: Anthropometric measurements

Variables	Obese	Non-obese	P-value
Weight (kg)	85.98±6.19	66.36±8.57	0.000
Height (m)	1.58±0.36	1.62±0.08	0.005
BMI (kg/m ²)	34.05±1.5	25.21±3.15	0.000

BMI: Body mass index

Table 2: Comparison of resting BP in obese and non-obese

Variables	Obese	Non-obese	P-value
Resting SBP	122.62±4.74	117.81±6.30	<0.05
Resting DBP	90.35±3.91	85.88±4.84	<0.05

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, BP: Blood pressure

Table 3: Comparison of increase in BP during IHGT in obese and non-obese

Category	SBP (mean±SD)	DBP (mean±SD)	P-value
Obese	9.85±2.78	8.54±1.94	<0.05
Non-obese	15.88±4.57	14.15±3.75	

BP: Blood pressure

Table 4: Comparison of increase of BP in CPT in obese and non-obese

Category	SBP (mmHg)	DBP (mmHg)	P-value
Obese	11.27±2.77	9.12±2.25	<0.05
Non-obese	17.00±3.80	14.62±3.03	

CPT: Cold pressor test, BP: Blood pressure

DISCUSSION

In the present study, we have compared together the autonomic status (sympathetic tests) of obese group with non-obese.

The mean resting BP was higher in obese than in non-obese and found to be statistically significant. The factors linking obesity to increase in BP are due to the increment in total blood volume and cardiac output that is caused partly by the increased metabolic demand induced by excess body weight and partly due to factors increasing peripheral vascular resistance such as insulin resistance, increased sympathetic activity, and substances released from adipocytes. The findings of the present study corroborate with different studies.^[12-16]

The increase in BP during IHGT results was lowered in obese than in non-obese and found to be statistically significant. This could be due to higher vasoconstrictor tone and increase in cardiac output due to increased load on heart, as a consequence of increased BMI. Sympathetic activation contributes to higher BP level in obese. Renal sympathetic nerve mediates sodium retention and hypertension in obesity. This finding corroborates with other studies by other investigators such as Shibao *et al.*

Galag *et al.* in 2011 conducted a study “Cardiovascular response to isometric HGT exercise test in obese and normal weight young adults” found the derangements in sympathetic cardiovascular function in the form of elevated baseline SBP, DBP, and decrease in response to handgrip dynamometer exercise test in obese group points toward autonomic imbalance.^[17]

The increase in BP during CPT was lowered in obese than in non-obese and found to be highly significant. Immersion of hands or feet for about 60–90 s in cold water (4°C) activates the afferent pain and temperature fibers from the skin as well as emotional arousal lead to sympathetic activation and increase in BP and heart rate. This finding corroborates with other studies^[13,14,18] which showed significant results for the change in SBP while not for the change in DBP.

In a study conducted by Nageswari *et al.* in 2007 titled, “Assessment of respiratory and sympathetic cardiovascular parameters in obese schoolchildren” by taking schoolchildren of 12–16 years of age group found a significantly positively correlation of higher baseline DBP in obese children with BMI. Increased DBP response to applied cold stimulus and borderline response to isometric exercise in obese children indicated autonomic instability. This corroborates with our study.^[19]

Garg *et al.* in 2013 conducted a similar study “A study of Autonomic function test in obese people” with 30 obese subjects in the age group of 21–40 years. Results showed that

isometric handgrip exercise test and CPT were significantly lower in obese as compared to control subjects.^[20]

In a study titled “Effect of obesity on autonomic nervous system” conducted by Grewal and Gupta in 2011 with 100 subjects, the mean change in SBP before and after CPT was less in obese group as compared to control group and this was statistically significant indicating impaired sympathetic status.^[18]

Limitations

The effect of obesity on SNS could be assessed by other tests such as mental arithmetic test and orthostatic test which has not been carried out in this study.

CONCLUSION

With regard to the above-mentioned data, it is evident that in obese, significant changes were observed in autonomic function test (HGT and CPT). Obesity is associated with autonomic dysfunction which may result in various cardiovascular complications. Hence, if this dysfunction is diagnosed early by doing various autonomic function tests, it will be of great help in identification of those which are prone to weight gain and at risk of various cardiovascular complications.

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