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Original Article

Relationship between Obesity and Sympathetic Nerve Function Status.

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Abstract

In order to assess the effect of obesity on sympathetic nervous system a cross-sectional observational study was carried out in the Department of Physiology, Sylhet MAG Osmani Medical College between January 2017 and December 2017. Fifty obese and age-sex matched 50 non-obese subjects were included. Two non-invasive cardiovascular sympathetic function tests like blood pressure response to postural change (orthostatic test) and blood pressure response to sustained handgrip were done to assess sympathetic nerve function status.The fall in systolic blood pressure (SBP) in orthostatic test of obese group (9.02 ± 2.29 mmHg) was significantly higher compared to non-obese group (4.84 ± 0.96) ($p<0.001$). Increase in diastolic blood pressure (DBP) in handgrip test of obese group (12.36 ± 2.78 mmHg) was significantly lesser than that of non-obese group (20.12 ± 2.64 mmHg) ($p<0.001$). The results of this study suggested that obese adults have reduced sympathetic activity.

Key words: Obesity, Sympathetic nerve function, Body mass index

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Introduction

Obesity is accumulation of fat results greater energy intake than energy expenditure. Obesity has become a major health challenge The prevalence of obesity has nearly doubled in the past decade and its incidence is still increasing rapidly in many countries, leading the World Health Organization to coin the word 'globesity' to describe the worldwide situation.[1]

Obesity is associated with an increased risk of cardiovascular disease, diabetes mellitus, musculoskeletal disorder especially osteoarthritis and many kinds of cancers like endometrial, breast and colon.[2]

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The prevalence of obesity was 4.6% in Bangladeshi adults.[3] Decreased sympathetic nervous activity has been highlighted as a effective mechanism predisposing to weight gain in human. Reduced sympathetic function may be the primary reason for excessive energy storage, it may be due to fault in sympathetic nerve activation or defect in peripheral adrenoreceptors.[2] Sympathetic under-activity may contribute to impaired thermo genesis, positive energy balance and weight gain.[4] Multiple factors like increased level of leptin, insulin, non-essential fatty acids and angiotensin-II, reduced circulating concentrations of adiponectin play role in sympathetic nervous system activity.[5] Moreover reduced sympathetic activity also could contribute to orthostatic hypotension and neurogenic syncope,[6] in contrast, sympathetic over-activity contributes to the development of obesity related hypertension.[4]

Many works are done by researchers in worldwide about the effect of obesity on sympathetic nervous system. There are many controversial reports on sympathetic nerve activity in obese persons. Some reports showed hyperactivity of sympathetic nerve function in obese persons.[7] Other showed lowered sympathetic activity in obese persons.[2,8]

Cardiovascular sympathetic function tests are non-invasive set of tests and are easily administrable in small clinical settings. Blood pressure response to sustained isometric handgrip test and Blood pressure response to postural change are commonly used cardiovascular sympathetic nerve function tests. [11,12,18]

On the other hand body mass index (BMI) is a simple, valid and inexpensive surrogate measure of obesity.[9] It has been observed that Asian people are more likely to develop obesity-related disorders when compared with BMI-matched individuals from other ethnicities.[10]

Obesity is an important and independent risk factor for cardiovascular morbidity and mortality. High incidence of cardiac autonomic nerve dysfunction has been noted in obese subjects. In addition to recognized complications of obesity, the probable association of sympathetic nerve dysfunction with certain cardiovascular disorders may also exist in obese person. To prevent the complications of obesity and to take effective measures, it is necessary to detect sympathetic nerve function in obese individuals. The present study was been designed to observe the relationship between obesity and sympathetic nerve activity. This relationship may help people to be conscious about obesity and prevent it by changing life style and weight reduction.

The hypotheses of the study will be like following:

Null hypothesis (H0): There is no relationship between obesity and sympathetic nerve function status.

Alternate hypothesis (H1): There is significant relationship between obesity and sympathetic nerve function status.

Materials and Method

This cross sectional observational study was carried out in the Department of Physiology, in collaboration with Department of Medicine, Sylhet MAG Osmani Medical College & Hospital during the period from January 2017 to December 2017.

Apparently healthy obese (BMI ≥27.5 kg/m^2) and non obese (BMI 18.5-22.9 kg/m^2) persons aged between 18-40 years were selected from Sylhet MAG Osmani medical College and Hospital staffs, attendants of admitted and outdoor patients fulfilling the inclusion criteria.

Inclusion criteria: Fifty apparently healthy adults aged 18 to 40 years with BMI ≥27.5 kg/m^2 were taken in obese group and another 50 age and sex matched subjects with BMI 18.5 to 22.9 kg/m^2 were taken in non obese group.

Exclusion criteria: Subjects with diabetes mellitus, chronic renal failure, stroke and other neurological disorders, any obvious cardiovascular diseases, chronic obstructive lung diseases, thyroid disorders, hypertensive patient receiving β– blocker, Alpha-blocker and diuretics were excluded.

Procedure of data collection: After full explanation of the purpose of the study informed written consent was obtained from the participants.

Assessment of the participants: All the participants were assessed from history, physical examination. Those who met the inclusion criteria were included in this study and person who met the exclusion criteria were excluded.

Assessment of Weight and Height: Weight was recorded in kilograms when the subject was standing on the weighing machine without shoes and minimum clothing. Height of the participants were recorded in the same weighing machine with the subject barefooted, feet together, back and heels against the upright bar of the height scale; head upright in Frankfort horizontal plane – look straight ahead. The height measuring equipment consisted of a vertical bar with a horizontal bar of wood which was brought down snugly on examinee's head.

Calculation of Body Mass Index: Body Mass Index (BMI) was calculated in the formula, BMI=Weight in Kilogram's/Height in meters^2.

Grouping of the sample: The participants were divided into two groups by their body mass index. Group A consisted of obese subjects with BMI BMI ≥27.5 kg/m^2 and Group B consisted of non-obese subjects with between 18.5-22.9 kg/m^2 each consisting 50 sample.

Laboratory investigations: After aseptic precaution 2ml venous blood was collected and analyzed for Random Blood Glucose and Serum Creatinine to screen Diabetes Mellitus and Chronic Renal Failure.

Sympathetic nerve function tests: Two non-invasive sympathetic nerve function tests (1) Blood pressure response to sustained handgrip test and (2) Blood pressure response to standing were performed.

Blood pressure response to sustained handgrip test:

1) At first the subjects were asked to sit quietly and their blood pressure was measured.
2) Then the subjects were asked to exercise maximum voluntary contraction by gripping the handgrip dynamometer for few seconds. The maximum force exerted was noted down.
3) Then the subjects were asked to grip at 30% of the maximum voluntary contraction for maximum 5 minutes and then again BP was measured.
4) The difference of diastolic BP between the resting condition and after the release of handgrip was calculated.

In blood pressure response to sustained handgrip test, rise in diastolic blood pressure 16 mm of Hg or greater was regarded as normal, 11-15 mm of Hg borderline and 10 mm of Hg or below as abnormal. [11,12]

Blood pressure response to standing: The subjects were asked to lie on bed. After 10 minutes rest, their BP was measured with the sphygmomanometer.
Then the subjects were asked to stand up as quickly as possible with pressure cuff tied around the arm. After 1 minute again BP was measured.
The difference of systolic BP between lying and 1 minute after standing was calculated.[2]
In pressure response to standing, fall in systolic BP 10 mm of Hg or less was regarded as normal, 11-29 mm of Hg as borderline and 30 mm of Hg or more as abnormal.[11,12]

Statistical Analysis: Collected data were processed and analyzed with the help of Statistical Package for Social Science (SPSS) Version 22.0. Quantitative data were expressed as mean and standard deviation; and comparison was done using Chi-Square (χ^2) test. Qualitative data were expressed as frequency and percentages; comparison was done using unpaired t test and Paired t test. P value of <0.05 was considered statistically significant.

Ethical Consideration: (1) After explaining the purpose of study, informed written consent was taken from each subject. (2) Prior to the commencement of the study, the research protocol was submitted to the ethical committee of Sylhet M.A.G Osmani medical college, Sylhet and an approval was obtained.

Results

The mean age was 35.56 ± 3.02 (range, 22-38) years in obese participants and 32.40 ± 4.20 (range, 22-38) years in non-obese participants. There was no significant difference between the mean age of obese participants and non-obese participants (t=1.585; p=0.116) (Table-I).
There were 26 (52.0%) male and 24 (48.0%) female in obese group; whereas 31 (62.0%) male and 19 (38.0%) female in non-obese group.
The sex difference between the participants of obese and non-obese group did not show any statistically significant difference (χ^2=1.020; p=0.313) (Table-I).

Table I. Comparison of participants according to demographic characteristics

Demographic characteristics	Study group		p value
	Group-A (n=50)	Group-B (n=50)	
Age (mean ± SD) years	35.56 ± 3.02	32.40 ± 4.20	p=0.116
Sex			
Male	26 (52.0%)	31 (62.0%)	*p=0.313
Female	24 (48.0%)	19 (38.0%)	

*Chi-Square (χ^2) Test and †unpaired 't' test were applied to analyze the data. SD: Standard deviation

The mean height of the obese participants was 1.61 ± 0.07 (range 1.47-1.78) meters; whereas the mean height of the non-obese participants was 1.63 ± 0.08 (range 1.42-1.73) meters. There was no significant difference between the mean height of obese and non-obese participants (t=-1.599; p=0.113) (Table-II).
The mean weight of the obese participants was 76.39 ± 10.08 (range 42-181) Kg; whereas the mean weight of the non- obese participants was 57.14 ± 6.56 (range 42-85) Kg. The mean weight of the obese participants was

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significantly higher than the non-obese participants (t=11.316; p<0.001) (Table-II).
The mean BMI of the obese participants was 29.39 ± 2.27 (range 18.3-31.9) Kg/M^2; whereas the mean BMI of the non- obese participants was 21.34 ± 1.02 (range 18.7-38.0) Kg/M^2. The mean BMI of obese was significantly higher than that of non-obese participants (t=22.885; p<0.001) (Table-II).

Table II. Comparison of participants by anthropometric status

Anthropometric status	Study subjects Group-A (n=50)	Group-B (n=50)	p-value
Height (Cm)	1.61 ± 0.07	1.63 ± 0.08	***p=0.133**
Weight (Kg)	76.39 ± 10.08	57.14 ± 6.56	***p<0.001**
BMI (Kg/M^2)	29.39 ± 2.27	21.34 ± 1.02	***p<0.001**

*Unpaired t test was employed to analyse the data.
Data were presented as mean ± SD (standard deviation).

The mean diastolic blood pressure (DBP) prior to hand grip test was 80.90 ± 7.19 mm Hg and after hand grip test was 93.26 ± 6.28 mm Hg in obese. The mean DBP was significantly rise after hand grip test in obese (t=–31.404; p<0.001) (Table-III).

Table III. Comparison of participants according diastolic blood pressure response to sustained hand grip test

DBP (mm Hg)	Study subjects Group-A (n=50)	Group-B (n=50)	p-value
Before hand grip test	80.90 ± 7.19	67.90 ± 7.22	***p<0.001**
After hand grip test	93.26 ± 6.28	88.02 ± 7.26	***p<0.001**
p-value	†p<0.001	†p<0.001	
Changed	12.36 ± 2.78	20.12 ± 2.64	***p<0.001**

*unpaired t Test and †paired t test were employed to analyse the data. Data were presented as mean ± SD (standard deviation).

The mean DBP prior to hand grip test was 67.90 ± 7.22 mm Hg and after hand grip test was 88.02 ± 7.26 mm Hg in non-obese. The mean DBP was significantly rise after hand grip test in non-obese (t=–53.908; p<0.001) (Table-III).
The mean change of DBP (rise of DBP) after hand grip test was 12.36 ± 2.78 mm Hg in obese and 20.12 ± 2.64 mm Hg in non-obese. The rise of DBP was significantly lower in obese compared to non-obese after hand grip test (t=–14.307; p<0.001) (Table-III).

Table IV. Comparison of participants according systolic blood pressure response to standing from lying

SBP (mm Hg)	Study subjects Group-A (n=50)	Group-B (n=50)	p-value
Lying	131.90 ± 9.68	109.70 ± 9.92	***p<0.001**
Standing	122.88 ± 9.64	104.86 ± 10.29	***p<0.001**
p-value	†p<0.001	†p<0.001	
Changed	9.02 ± 2.29	4.84 ± 0.96	***p<0.001**

*unpaired t Test and †paired t test were employed to analyse the data.
Data were presented as mean ± SD (standard deviation).

The mean systolic blood pressure (SBP) at lying was 131.90 ± 9.68 mm Hg and at standing was 122.88 ± 9.64 mm Hg in obese participants. The mean systolic blood pressure was significantly lower at standing compared to lying position in obese (t=27.851; p<0.001) (Table-IV).
The mean SBP at lying was 109.70 ± 9.92 mm Hg and at standing was 104.86 ± 10.29 mm Hg in non-obese participants. The mean SBP was significantly lower at standing compared to lying position in non-obese (t=35.824; p<0.001) (Table-IV).
The mean change of SBP (fall) at standing from lying was 9.02 ± 2.29 mm Hg in obese and 4.84 ± 0.96 mm Hg in non-obese. The fall of SBP at standing from lying was significantly higher in obese participants compared to non-obese participants (t=11.912; p<0.001) (Table-IV).

Discussion

In this study the mean age was 35.56 ± 3.02 and 32.40 ± 4.20 years (p=0.116); sex 52.0% male versus 62.0% male (p=0.313) did not differ significantly between obese and non-obese participants. Several study supported these results. [2,13]

In this study the mean height of the obese participants was 1.61 ± 0.07 meters; whereas the mean height of the non-obese participants was 1.63 ± 0.08 meters. The mean height of obese and non-obese participants did not differ significantly (p=0.113). This result correlated with several studies.[2,14]

This study revealed that the mean weight of the obese participants was 76.39 ± 10.08 Kg; whereas the mean weight of the non- obese participants was 57.14 ± 6.56. The mean weight of the obese participants was significantly higher than that of non-obese participants (p<0.001). This finding was consistent with other studies.[2,15]

In the present study the mean BMI of the obese participants was 29.39 ± 2.27 and the mean BMI of the non- obese participants was 21.34 ± 1.02 Kg/M^2. The mean BMI of obese was significantly higher than that of non-obese participants (p<0.001). This result was consistent with several studies.[2,16]

In this study the mean change of diastolic blood pressure (rise of DBP) after sustained hand grip was 12.36 ± 2.78 mm Hg in obese participants and 20.12 ± 2.64 mm Hg in non-obese participants. The rise of DBP after sustained hand grip was significantly lower in obese participants compared to non-obese participants (p<0.001). Bedi et al.[17] reported rise of DBP after hand grip testing was significantly lower in obese than non-obese (p<0.05). Chaudhuri et al.[18] also reported rise of DBP after sustained isometric handgrip testing was significantly lower in obese than non-obese (p<0.05). Several other studies also revealed increase in DBP in isometric handgrip was significantly lower in obese compared to non-obese.[2,9] But Shetty et al.[15] did not find significant difference in the rise of DBP after sustained isometric handgrip testing between obese group and non-obese (p=0.329). The reduced DBP response in obese group is more likely to be due to a reduced increase in peripheral vascular response to maneuvers activating sympathetic system.[19]

This study also demonstrated that he mean change of systolic blood pressure (fall of SBP) from lying to standing was 9.02 ± 2.29 mm Hg in obese participants and 4.84 ± 0.96 mm Hg in non-obese participants. The fall of SBP from lying to standing was significantly higher in obese participants compared to non-obese participants (p<0.001). Chaudhuri et al.[18] reported blood pressure response to postural change (orthostatic tolerance test), the fall of SBP was significantly higher in obese than non-obese (p<0.01). Das and Mondal,[9] also reported that the fall in SBP in orthostatic test of obese group was significantly higher in obese than non-obese (p= 0.0001). But Shetty et al.[15] did not find significant difference in the fall in SBP in orthostatic test between obese group and non-obese (p= 0.215).

Obese persons have decreased responsiveness to sympathetic stimulation and down regulated β receptors in white adipose tissue. Gaining weight combines regularly with metabolic changes revealing adaptation processes towards "resistance" of feedback loops involved especially in organ systems ensuring supply and utilization of energy.[10] This reduced sympathetic activity may contribute to deficient thermogenesis, positive energy balance, and weight gain in humans.[4] This reduced sympathetic activity may be the result of a defect in sympathetic nerve activation or alternatively in peripheral adrenoreceptors behavior.[2] This effect of gaining weight is one mechanism for cardiac complications such as arrhythmias that accompany obesity.[20]

Limitations of the study were (1) this study was carried out in a tertiary hospital. So the study was limited to only one centre and the result of this study can not be generalized (2) sample size was small due to time constrain and (3) sampling was non-random.

Conclusion

This study revealed that significant reduction in rise of diastolic blood pressure in response to sustained handgrip with a greater fall of systolic blood pressure in response to standing in the obese subjects. The study results suggested that obese adults have reduced sympathetic activity. Hence, a screening cardiac sympathetic activity in adult obese may help in the detection of altered sympathetic activity in the early stage for appropriate steps towards prevention of any complication related to altered sympathetic function. However further multicenter study involving large sample should be conducted to reach a valid conclusion and recommendation.

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