

Sympathetic Cardiovascular Nerve Function Status in Overweight Individuals

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Abstract

Background:

Overweight can lead to adverse health outcomes such as increased cardiovascular disease risk and chronic conditions that decrease overall quality of life. Reduced sympathetic activity represents a preclinical marker in the pathogenesis of cardiovascular disease in overweight individuals.

Objective:

The study aimed to assess the cardiovascular sympathetic nerve function status in normal weight and overweight individuals.

Methods:

This cross-sectional analytical study was conducted from July 2017 to June 2018 in the Department of Physiology, Rangpur Medical College, Rangpur, Bangladesh. After obtaining permission the participants who would meet the inclusions and exclusions criteria were enrolled in the study after briefing them about objectives. A total number of 80 age, sex matched individuals were selected, among them 40 were apparently healthy normal weight individuals (group-A) and 40 were apparently healthy overweight individuals (group-B). Two simple noninvasive cardiovascular reflex tests like blood pressure response to sustained handgrip and standing were done to assess cardiovascular sympathetic nerve functions status. Baseline systolic and diastolic blood pressure recording was done during resting condition. The participants were selected by purposive sampling method from different areas of Rangpur division, Bangladesh. For statistical analysis, unpaired 't' test was performed by computer-based software SPSS 23.0 version for windows.

Results:

Overweight individuals had both higher mean systolic blood pressure ($p < 0.05$) and mean diastolic blood pressure than normal weight individuals in resting condition. And overweight individuals had lower blood pressure response to sustained handgrip ($p < 0.05$) and standing ($p > 0.05$) than normal weight individuals. Rise of mean diastolic blood pressure in response to sustained handgrip in overweight was significant (18.2 ± 2.86 vs 15.68 ± 5.17 ; $p = 0.24$) but fall of mean systolic blood pressure in response to standing in overweight was not significant (8 ± 2.95 vs 6.68 ± 2.8 ; $p = 0.105$).

Conclusion:

Reduced sympathetic activity in overweight individuals indicate modifications in cardiovascular autonomic nerve functions and this could make them prone to future development of various cardiovascular complications.

Key words: Overweight, Blood pressure

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Introduction:

Overweight is one of the common health hazards and associated with autonomic dysfunction.^{1,2} The prevalence of overweight individuals is increasing at an alarming rate. World health organization

(2016) estimate that more than 1.9 billion adults were overweight globally.³ In Bangladesh, rate of overweight adults claimed 7% to 17% from 1980 to 2013.⁴

Overweight is a disorder of energy balance

affecting a wide range of people.⁵ When a person's body mass index is above the normal range but below the threshold for obesity, he or she is termed as overweight.⁶ The causes of overweight are over consumption of high calorie food, sedentary habits, lack of regular exercise and genetic.⁷ Overweight is determined by BMI value and waist circumference.⁸ The WHO recommends the values for overweight and obesity for Asian populations as follows:

	BMI	WC:	
		Male	Female
Normal weight	18.5 to 22.9 kg/m ²	<90cm	<80cm
Overweight	23 to 24.9 kg/m ²	≥90cm	≥80cm
Obese	≥ 25 kg/m ²	≥94cm	≥88cm

The increasing number of people who overweight are contributing to the growing burden of non-communicable diseases.⁹ Autonomic nerve dysfunction also co-exist in addition to recognized complication caused by overweight.^{7,10} Globally 4.5 million deaths were estimated due to complication caused by overweight and obesity.¹¹ Augmented sympathetic reactivity might predispose overweight individuals to developing hypertension and cardiovascular diseases.¹² The sympathetic functions can be assessed by using two simple noninvasive tests based on cardiovascular reflexes, effective for diagnosis of early autonomic dysfunction.¹³ These tests are blood pressure response to standing and sustained handgrip.¹⁴⁻¹⁷ In handgrip test increase in diastolic blood pressure is due to increase peripheral resistance.¹⁸ But in overweight diastolic blood pressure response is more likely to be reduced after sustained handgrip test.¹⁶ Blood pressure response to standing causes pooling of blood in the legs causes a fall in blood pressure, which is normally corrected by peripheral vasoconstriction.¹⁹ There is relatively lower blood pressure response to standing in overweight individuals.²⁰ This decreased sympathetic activity may be the result of a defect in sympathetic nerve activation or alternatively in peripheral vasoconstrictor fibers activity.²¹

At an early-stage autonomic dysfunction may be asymptomatic. Unfortunately, most overweight

people remain unnoticed and usually treated without knowing the underlying etiology. Therefore, from the findings of this study, we might suggest that early diagnosis is essential for maximum benefit as autonomic disturbances carries worst prognosis.

Methods:

This cross-sectional analytical study was conducted in the Department of Physiology, Rangpur Medical College from July 2017 to June 2018. A total number of 80 apparently healthy subjects, aged 20-40 years were included in this study from different areas of Rangpur by purposive sampling method. Before performing tests all the subjects were briefed about the objectives and informed written consents were taken. A standard questionnaire was filled up after taking history and thorough clinical examinations.

All the study participants were divided into two groups based on their body mass index. Apparently healthy 40 subjects of BMI 18.5- 22.9 kg/m² were normal weight (Group A) and 40 BMI 23- 24.9 kg/m² were overweight (Group-B). Study was carried out with prior protocol approved by the thesis protocol review and ethical committee of Rangpur Medical College. Obese and history of diabetes mellitus, chronic renal failure, hypertension, cardiac complication, chronic obstructive lung diseases, smoking and alcohol abuse, any neurological disorder, psychiatric disorders (depression) taking any neurotoxic drug, endocrine disorders and previous history of head injury were excluded. For calculation of BMI weight in Kg and height in m² of each subject was taken by medical weighing machine and measuring tape respectively for measuring waist circumference (WC).

From the previous night up to the examination, they should not undergo any physical or mental stress and not to take any sedatives or any drugs affecting central nervous system. Then the sympathetic nerve functions parameters were assessed by cardiac autonomic reflex tests. These tests were conducted in a comfortable environment in the departmental physiology laboratory from 9.00am-2.30pm.

Resting blood pressure:²²

The participants were asked to take rest for 10 minutes. The resting blood pressure was recorded

in supine position using mercury sphygmomanometer and expressed in mmHg. Three readings were taken and the average of the three was taken as the resting blood pressure.

Tests to determine sympathetic activity:^{4,19,20,23,24}

i. Blood pressure response to sustained handgrip:

The participant's resting blood pressure was recorded. Then they were asked to grip the inflated cuff of a sphygmomanometer. The handgrip then maintained at 30% maximum voluntary contraction for maximum 5 minutes and then again blood pressure was measured. Difference in the diastolic blood pressure before and after sustained handgrip was calculated.

Normal: ≥ 16 mmHg, Borderline: 11-15 mmHg, Abnormal: ≤ 10 mmHg

ii. Blood pressure response to standing:

The participants were made comfortable and asked to lie down on the bed and relax for 10 minutes; initial blood pressure was recorded by sphygmomanometer. They were asked to stand up immediately with pressure cuff tied around their arms. Again, blood pressure recorded after 1 minute of standing. The difference in systolic blood pressures between lying and after standing for 1 minute is calculated.

Normal: ≤ 10 mmHg, Borderline: 11-29 mmHg, Abnormal: ≥ 30 mmHg

All data were recorded systematically in a preformed history sheet and all statistical analysis was done by computer using the software SPSS 23.0 version for windows. Comparison between study groups and overweight with control group (normal weight) was done by unpaired t test. In the interpretation of results, <0.05 level of probability (p) was accepted as significant.

Results:

There was no significant difference in mean age (group-A vs group-B= 29.1500 ± 6.33489 vs 30.7 ± 7.63 ; $p=0.586$) and height (group-A vs group-B= 1.62 ± 0.12 vs 1.65 ± 0.09 m; $p=0.321$). The mean height was 1.62 ± 0.12 m in group-A and 1.65 ± 0.09 m in group-B ($p<0.001$) and the mean weight was 56.15 ± 8.53 kg in group-A, 63.07 ± 8.08 kg in group-B ($p<0.001$). The mean BMI were 21.39 ± 0.95 kg/m² in group-A, 23.63 ± 0.54 kg/m² in group-B ($p<0.001$) (Table-I).

Table-I: Mean \pm SD of age, height, weight, WC and BMI of the study participants

Parameters	Mean \pm SD		p-value
	Group A (n=40)	Group B (n=40)	
Age-years	29.15 ± 6.33	30.7 ± 7.63	0.586
Height-m	1.61 ± 0.12	1.65 ± 0.09	0.321
Weight- kg	56.15 ± 8.53	63.06 ± 8.08	0.001
BMI-kg/m ²	21.39 ± 0.95	23.63 ± 0.54	0.000
WC-cm	71.82 ± 6.55	86.7 ± 5.22	0.000

Overweight individuals had both higher mean systolic blood pressure ($p<0.05$) and mean diastolic blood pressure than normal weight individuals in resting condition (Table-II).

Table-II: Mean \pm SD of resting systolic and diastolic blood pressure of the study participants

Blood pressure (mm of Hg)	Mean \pm SD		p-value
	Group A (n=40)	Group B (n=40)	
Resting systolic blood pressure	114.75 ± 10.19	120.5 ± 9.32	0.027
Resting diastolic blood pressure	72.5 ± 7.84	74.38 ± 8.41	0.560

Rise of mean diastolic blood pressure in response to sustained handgrip were 18.2 ± 2.86 in group A and 15.68 ± 5.17 in group B ($p=0.24$).

Table-III: Mean \pm SD of blood pressure response to sustained handgrip (DBP) in study participants

Variables	Mean \pm SD		p-value
	Group A (n=40)	Group B (n=40)	
Rise in diastolic blood pressure (mm of Hg)	18.2 ± 2.86	15.678 ± 5.17	0.024

Table-IV: Mean \pm SD of blood pressure response to standing (SBP) in study participants

Variables	Mean \pm SD		p-value
	Group A (n=40)	Group B (n=40)	
Fall in systolic blood pressure (mm of Hg)	8 ± 2.95	6.68 ± 2.8	0.105

Discussion:

In this study we found a high prevalence of early autonomic change in overweight individuals. Two tests were done to assess the sympathetic nerve functions, blood pressure response to sustained handgrip and standing. The result showed that, in overweight individuals mean values of resting systolic blood pressure were significantly higher and diastolic blood pressure was higher but non-significant. This finding was consistent with some other investigators.^{15,21,25} Again, it was observed in this study that in overweight individuals, diastolic blood pressure response to sustained handgrip significantly lower¹⁵ and systolic blood pressure response to standing lower but non-significant.^{3,9} The results of the study correlate with observations made by other authors.^{15,26}

Sympathetic nervous system is a determinant of energy expenditure.²⁷ The lower sympathetic activity related to a positive energy balance and increase of body weight.²⁸ The higher basal blood pressure in overweight individuals may be due to the increased adipose tissue demands additional blood flow, which increases cardiac output or by vasoconstriction, increase total peripheral resistance.²¹ Some authors expressed their view regarding impaired sympathetic activity in overweight may be leptin hormones, released from fat cell directly stimulate hypothalamus, which excites vasomotor centers of the medulla.²⁹ The overweight group showed reduced blood pressure response to sustained handgrip due to reduced increase in peripheral vascular response to maneuver activating sympathetic system.^{5,21} Measuring the reflex autonomic responses on standing provides information on the integrity of afferent, central and efferent baroreflex pathways.³⁰ Standing produces immediate fall in cardiac output due to gravitational blood pooling. Activation of baroreceptors initiates the baroreflex regulating the sympathetic and cardiovascular response. Because these baroreceptors are located inside the arterial wall and are triggered by stretching, arterial stiffness may interfere in its activation, thereby implicating abnormal vascular response as a contributing factor in orthostatic blood pressure changes.³¹

Abnormalities in autonomic sympathetic responses may precede the development of overt clinical disease in overweight individuals. To reduce the effects of subsequent cardiovascular

complications, early identification is important for recognizing not only obese but also overweight individuals as an at-risk population.¹³

Limitations:

Sample size was small and drawn from one limited geographical area, which is inadequate for extrapolating the application of these findings to the general population. As this study had few females, effects of gender on autonomic function test was not studied.

Conclusion:

The fall of systolic blood pressure after standing and diastolic blood pressure after sustained handgrip indicating sympathetic insufficiency in overweight individuals. Hence, a screening by sympathetic cardiovascular autonomic function tests provide information about early subclinical cardiac autonomic dysfunction and help in the prevention of any complications related to alter ANS functions.

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