International Journal of Basic and Applied Medical Sciences ISSN: 2277-2103 (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jms.htm
2015 Vol. 5 (1) January-April, pp. 212-215/Pal et al.
Research Article

EFFECT OF BODY WEIGHT ON CARDIAC FUNCTION

***Pal N., Soni N.D. and Kumar J.**
Department of Physiology, Dr S N Medical College, Jodhpur
**Author for Correspondence*

ABSTRACT
Body mass has been associated with changes in the cardiac autonomic activity and a potential risk factor for cardiovascular morbidity and mortality. So investigations of autonomic nerve functions in obese, for detection of early autonomic impairment can be potentially important to prevent complications. The aim of this experiment was to see the cardiac autonomic activity and its relation with body weight. Total 152 subjects were taken for study between age group 15 to 45 years. They were divided into three different age groups, group (I) -15 to 25 years, group (II) 26 to 35 years and group (III)-36 to 45 years. Each group was further divided into three subgroups on the basis of their Body Mass Index. Group A, BMI -18.6 to 24.9 (normal weight), Group B-BMI- 25 to 29.9(overweight) and group C- BMI- >30 (obese). Blood Pressure changes were observed before, during and after Cold Pressor test, to see the sympathetic activity in all three groups. Statistical analysis was done using one way ANOVA test with GraphPad inStat3 software. The change in systolic and diastolic blood pressures before and after cold pressor test (CPT) was decreasing with increase in Body Mass Index and this decrease was statistically significant indicating impaired sympathetic function in overweight and obese subjects. Thus in obese, sympathetic division of (Autonomic Nervous System) ANS get affected which may be the cause of various cardiovascular complications.

Keywords: *Obesity, Body Mass Index, Cold Pressure Test*

INTRODUCTION
The causes of obesity are manifold that include lack of regular exercise, sedentary habits, over consumption of high calorie foods, and genetic, perinatal and early life factors. Obesity can also be a side-effect of certain disorders and conditions, including: psychological factors, such as depression and low self esteem emotional and social problems. Over the years concern has been grown on the fact that increasing obesity among adults might affect their cardiovascular health. Hence obesity may affect the heart and lungs through its influence on the known risk factors of hypertension, dyslipidemia and glucose intolerance. The cardiovascular disorders due to obesity result in increased mortality from coronary artery disease, heart failure, arrhythmias and sudden death (Venkatnarayan *et al.*, 2001).

Obesity related health problems including various cardiovascular and metabolic diseases are not uncommon in our community. In addition to recognized complications of obesity, autonomic nerve dysfunction also coexists with certain cardiovascular disorders in obese person. In obese persons, investigations of autonomic nerve functions can be potentially important for detection of early autonomic nerve function impairment which there by may be helpful to prevent its complications (Akhter, 2008).

Several protocols have been established to trigger psychological and physiological stress responses in a highly standardized and reliable manner (Hines, 1936). A commonly used technique to rapidly elicit a stress reaction is a cold Pressor Test (CPT), in which the subject's hand is immersed in ice-cold water for a short period of time. This physiological stressor leads to stress responses such as elevations in blood pressure, heart rate, and adrenaline and noradrenaline concentrations (Nina, 2014). Cold pressor response is an indicator of sympathetic activity after cold stress. Cold stress causes massive discharge of the sympathetic nervous system and release of norepinephrine. This sympathetic discharge triggers responses in the cardiovascular (CV) system that includes arteriolar constriction, increased HR, and increased cardiac contractility. These responses combine to increase BP. This is known as the pressor response, and testing a subject with cold stress in this fashion is known as the cold pressor test. The cold pressor test has been used clinically as a stress test to assess left ventricular function. The test is also used to evaluate cardiac autonomic function and as CPT produces an increase in heart rate, total vascular resistance,

arterial blood pressure and cardiac output attributable to increased sympathetic vasomotor neuronal activity (Silverthorn, 2013).

MATERIALS AND METHODS

The present study was conducted in Dr S N Medical College; Jodhpur, and the study was approved by the Institutional Ethical Committee. One hundred and fifty two volunteer subjects were selected randomly for the study, of age 15 to 45 years. Height was measured using a standard stadiometer with the subject standing in an erect posture without shoes. The readings were taken to the nearest 0.1cm. Weight was recorded in kilograms using a calibrated weighing machine scale with a capacity of 120 kg and a sensitivity of 0.05 kg. The BMI was calculated as the weight in kilograms divided by the square of the height in meters [weight (kg)/height (m^2)]

Subjects were divided into 3 different age groups

Group I- 15 to 25 years

Group II- 26 to 35 years

Group III- 36 to 45 years

These three age groups were furthers divided into three subgroups according to body weight as per WHO classification on BMI.

Normal weight group with BMI **18.5-24.9 kg/m^2**

Overweight group with BMI **25-29.9 kg/m^2**

Obese group with BMI **>30 kg/m^2**

A prior informed written consent was obtained from the subjects participating in the study.

Exclusion Criteria Included:-History of cardiovascular disorder, fainting or seizures, frost bite, open cut or sore on hand to be immersed, fracture of limb to be immersed

Cold Pressor Test (CPT): After the baseline recording of blood pressure, the subjects were made to undergo cold pressor test i.e. each subject immersed his one hand (upto wrist) in ice-cold water at 4-8^{0}C, contained in a large beaker, and to take out their hand after one minute. Blood pressure was measured during immersion of hand in cold water and also after removal of hand from cold water for consecutive 3 minutes. Then difference of resting blood pressure and maximum change in blood pressure was taken as ΔSBP and ΔDBP.

RESULTS AND DISCUSSION

Table 1: Change in blood pressure during cold pressure test

Parameters	Age Group	Normal Weight	Overweight	Obese	p-value
CPT	15-25	12.88±4.31(41)	10.27±5.8(15)	8.91±6.89(11)	.04*
[ΔSBP]	26-35	10.92±8.06(19)	10.92±8.06(12)	7.75±4.46(8)	.03*
	36-45	13.2±9.44(10)	10.82±8.05(17)	6.53±4.31(19)	.04*
CPT	15-25	11.95±5.39(41)	9.2±8.48(15)	6.91±5.68(11)	.04*
[ΔDBP]	26-35	10.21±4.32(19)	8.08±5.53(12)	4.25±3.28(8)	.01*
	36-45	10.8±6.34(10)	8.11±5.12(17)	5.79±3.71(19)	.03*

**p-value <0.05 is significant*

Data presented in Table shows that change in systolic and diastolic blood pressure in all three age groups(Group I, Group II and Group III) is decreasing with increase in body mass index and the decrease is statistically significant ($p<0.05$).

The result shows that as body mass index increases, change in the blood pressure response is decreasing. It indicates overweight and obese group is less responsive to blood pressure changes to cold stimulus than the normal weight group. The afferent fibers for this response are the pain fibers which are stimulated by placing the hand in cold water and the efferent fibers are the sympathetic fibers. A lesser increase in the blood pressure after the cold water immersion points towards sympathetic insufficiency in obese subjects.

With increase in Body Mass Index impairment of autonomic control of heart rate and blood pressure was found, so obese subjects exhibit lower sympathetic response on exposure to cold.

One study stated that in normal conditions sympathetic activity increases during cold pressor test. This reduced sympathetic reactivity in established obesity may be responsible for the maintenance of obese state (Baeks, 2000). Another study also has demonstrated sympathetic insufficiency in obese people. It was shown that glucose induced inhibition of the lipid oxidation rate in obese people is greater in the patients with autonomic dysfunction which could be due to decrease in parasympathetic activity (Valensi, 1998).

Another author reported an association between the increase in body fat and hypoactivity of sympathetic and parasympathetic components of ANS. The authors state that lower sympathetic activity is related to lower energy expenditure and, consequently, to a positive energy balance and increase of body weight. Decrease in the sympathetic activity may result in a disordered homeostatic mechanism thus promoting excessive storage of energy (Peterson, 1988).

A study conducted by Nagai provided evidence of autonomic depression in obese children which was associated with duration of obesity (Nagai, 2003). Same as our result Bedi, also found the decreased sympathetic response in obese subjects compare to the control non obese group (Bedi, 2009). Autonomic disturbances, however, appear to be reversible with weight reduction. Since autonomic imbalance is a marker of adverse risk, improvement obtained from weight loss should be beneficial for the health of individuals with obesity and diabetes. This overview will examine the relationship of the autonomic nervous system in obesity and diabetes and explore the effect of weight loss on autonomic function (Maser, 2007).

The Cold pressor test (CPT) elicits the pressor response to a cold stimulus and is an indicator of vasoconstrictor tone. The response of blood pressure to Cold pressor test is characteristic for the individual. In the present study, the maximal/ceiling value as well as range/response (Δ) of diastolic blood pressure during cold pressor test was found to be higher in test group subjects as compared to control group.

Hines and coworkers indicated that the vasopressor response to locally applied cold was due to an increase in the total peripheral resistance as a result of vasoconstriction and that the cardiac output did not change (Hines, 1936; Hines, 1933).

On the contrary, another author has mentioned that the pressor response in most normotensive subjects was due to a rise in cardiac output and the pressor response in hypertensive subjects was due to an increase in peripheral resistance (Hejl, 1957). These findings concluded that BP responses to cold are probably influenced by different factors related to participants emotional state and coping style (Lambert, 2004; Germano, 2003).

In overweight children initially sympathetic stimulation occur to reduce body weight (catabolic effect). That causes an increase in vasomotor tone & cardiac output. So the final result is increase in basal SBP, DBP & MAP in overweight children (Sorof, 2005). But beyond equilibrium, sympathetic nervous system cannot act to reduce body weight. This causes sympathetic insufficiency in chronic overweight children which makes them pre-hypertensive. This is shown by these tests. Cold pressure test is an indicator of vasoconstrictor tone. The lesser increase in SBP, DBP & MAP during cold pressure test from its basal value in overweight boys in compare to control group suggest sympathetic insufficiency (De-Simone, 1990). One more study finding was that HR and BP responses were reduced in obese subjects when compared to the non-obese subjects (Monteiro, 2012). It is a well-known fact that the cold pressor test provokes a remarkable increase in sympathetic activity in humans mediated by central command and local metabolites, particularly adenosine.

Conclusion

Our results suggest that as Body Mass Index increases, modifications in the ANS found, characterized by a reduction in sympathetic activity. This finding strongly indicates the need for the early diagnosis of dysfunction 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.

REFERENCES

Akhter S,Begum N, Ferdousi S(2008). Relationship Between Obesity And Parasympathetic Nerve Function. *Journal of Bangladesh Society of Physiologist* **3** 50-54.

Baeks MA Van (2000). The peripheral sympathetic nervous system in human obesity. *Journal of Endocrinology* **164** 59-66.

Bedi M, Khullar S and Varshney Varshney VP (2009). Assessment of Autonomic Function Activity in Obese Children. *Vascular Disease Prevention* **6** 139-141.

De Simone G, Mancini M, Turko S, Marotta I, Gaeta I, Lannuzzi R, Ferrara LA and Mancini M (1990). Cardiovascular response to the cold test in obese subjects. Effect of a hypo caloric, normal sodium diet. *Minerva Endocrinologica* **15**(4) 231-233.

Germano G, Lintas F, Truini A, Raggazzo M, Lannetti GD and Sperduti L (2003). Blood pressure. *High Blood Pressure and Cardiovascular Prevention* **2**(10) 87-90.

Hejl Z (1957). Changes in cardiac output and peripheral resistance during simple stimuli influencing blood pressure. *Cardiologia* **31** 375.

Hines EA Jr and Brown GE (1933). Standard test for measuring variability of blood pressure: Its significance as an index of prehypertensive state. *Annals of Internal Medicine* **7** 209.

Hines Jr EA and Brown GE (1936). The Cold Pressor test for measuring reactibility of blood pressure: data concerning 571 normal and hypertensive subjects. *American Heart Journal* **11** 1-9.

Lambert EA and Sclaich MP (2004). Reduced sympathoneural responses to cold pressor test in individuals with essential hypertension and in those genetically predisposed to hypertension. *American Journal of Hypertension* **17**(10) 863- 868.

Maser RE and Lenhard MJ (2007). An overview of the effect of weight loss on cardiovascular autonomic function. *Current Diabetes Reviews* **3**(3) 204-211.

Monteiro G and Chathoth V (2012). Cardiac autonomic response during a cold presser test in normal and overweight adults. *IJBAR* **03**(06) 514-516.

Nagai N (2003). Autonomic nervous system activity and the state and development of obesity in Japanese school children. *Obesity Research & Clinical Practice* **11** 25-32.

Nina MA and Thomas P (2014). The socially evaluated cold-pressor test (SECPT) for groups: Effects of repeated administration of a combined physiological and psychological stressor. *Psychoneuroendocrinology* **45** 119-127.

Peterson HR, Rothschild M, Weinberg CR, Fell RD, McLeish KR and Pfeifer MA (1988). Body fat and the activity of the autonomic nervous system. *New England Journal of Medicine* **318** 1077-1083.

Silverthorn D and Michael J (2013). Cold stress and the cold pressor test. *Advances in Physiology Education* **37** 93-96.

Sorof J and Daniels S (2005). Obesity hypertension in children. A problem of epidemic proportions. *Hypertension* **45** 1159-1164.

Valensi P, Lormeau B, Dabbech M, Miossec P, Paries J and Dauchy F (1998). Glucose induced thermogenesis, inhibition of lipid oxidation rate and autonomic dysfunction in nondiabetic obese women. *International Journal of Obesity* **22** 494-499.

Venkatnarayan KM, Campagna AF and Imperatore G (2001). Type 2 diabetes in children: a problem lurking from India? *Indian Pediatrics* **38** 701-704.