ORIGINAL RESEARCH

To investigate the correlation between Body Mass Index (BMI) and sympathetic function in adult males using the Cold Pressor Test (CPT)

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ABSTRACT

Aim: To investigate the correlation between Body Mass Index (BMI) and sympathetic function in adult males using the Cold Pressor Test (CPT). **Material and Methods:** The research recruited 80 volunteers between the ages of 18 and 30 years, with a body mass index (BMI) ranging from 18 to 30 kg/m2.The cuff was fastened securely around the dominant upper arm, about 2-3 cm above the elbow. Next, thess stethoscope's bell was gently placed above the brachial artery and the air pump was compressed, causing the mercury level to rise to 40-50 mmHg above the systolic level obtained by the palpatory approach. The pressure was gradually reduced until a distinct rhythmic sound was detected, and the blood pressure was measured using the auscultatory technique.The subject's dominant arm was submerged in icy cold water and within one minute, systolic and diastolic blood pressure were recorded. **Results:**With normal BMI, 12 subjects were normal SBP, 37 subjects were pre-hypertensive and 1 subject was stage 1 hypertensive. In overweight, 1 subject was normal ,9 subjects were pre-hypertensive and 1 subject was stage 1 hypertensive. In obese, 2 subjects were normal, 11 were pre-hypertensive and 6 subjects were stage 1hypertensive.With normal BMI, 16 subjects were normal DBP, 31 subjects were pre- hypertensive and 3 subjects were stage 1 hypertensive. In overweight, 2 subjects were normal, 7 subjects were pre- hypertensive and 2 subjects were stage 1 hypertensive. In obese, 3 subjects were normal, 6 subjects were pre-hypertensive, 8 subjects were stage 1 hypertensive and 2 subjects were stage 2 hypertensive. **Conclusion:**After doing the Cold pressor test, we determined that there was an increase in sympathetic activity among those who were overweight or obese compared to those with a normal body mass index.

Keywords: Cold pressor test, BMI, SBP, DBP

INTRODUCTION

Obesity is a medical disorder characterized by the excessive accumulation of body fat, which may have negative effects on health, including a shorter lifespan and increased health issues[1]. Obesity is characterized by an excessive amount of body fat, however it is now defined practically by evaluating the body mass index (BMI). BMI is determined by dividing an individual's weight by the square of their height, using Quetelet's Index. Individuals whose body mass index (BMI) falls between the range of 18.5 to 24.9 kg/m2 are classified as having a normal weight. Individuals whose BMI is between the range of 25.0 to 29.9 kg/m2 are classified as overweight, whereas those with a BMI over 30.0 kg/m2 are classified as obese[2].

Obesity and overweight rank as the sixth most significant cause of worldwide mortality. Globally, the prevalence of obesity has increased by about 100% since 1980. In 2016, the global population of overweight people aged 18 and above exceeded 1.9 billion. Out of them, more over 650 million individuals, both male and female, were classified as obese[3]. Annually, a minimum of 3.4 million

individuals succumb to mortality due to their overweight or obese condition. Furthermore, overweight and obesity contribute to 44% of the diabetes burden, 23% of the burden of ischemic heart disease and 7-41% of the burden of some cancers [3].
The second phase of the non-communicable risk factor study was conducted in India during the year 2007-2008. The survey included the states of Andhra Pradesh, Kerala, Madhya Pradesh, Maharashtra, Tamil Nadu, Uttarakhand, and Mizoram. The study revealed a significant prevalence of overweight in all age categories, with the exception of 15–24-year age group. The incidence of overweight was greater among females than men and higher in urban regions compared to rural ones. The incidence of the condition was shown to be low among those with a lower level of education, as well as among those whose profession was related to agriculture or manual labor[4]. In 2008, the prevalence of obesity among men in India aged over 20 years was 1.3%, while among females it was 2.5%[5].
Obesity has a significant role in the development of various chronic and non-communicable illnesses. The first detrimental consequences of obesity that arise in the transitioning population are hypertension, hyperlipidemia, and glucose intolerance. However, coronary heart disease and the chronic problems of diabetes, such as kidney failure, become apparent some years later[6].
Obesity often occurs when there is an unequal distribution of energy intake and energy expenditure, known as energy homeostasis, which is regulated by the autonomic nervous system (ANS). This imbalance arises from complex interactions involving genetic, physiological, behavioral, environmental, endocrine, neurological, and metabolic variables, which ultimately cause changes in both hemodynamics and metabolism [7,8].
The cold pressor test affects cardiovascular function in reaction to discomfort. An erratic reaction to CPT [9] is a sign of probable hypertension. Temperature has an impact on both heart rate and blood pressure. The CPT or Cold Pressor Test is used to assess an individual's physiological reaction to external stimuli. The increase in blood pressure (BP) after the cold pressor test (CPT) aids in assessing the autonomic cardiovascular function associated with stress. Stress impacts several functions, including the neurological system, endocrine system, cardiovascular system, and immunological system. Activation of the sympathetic system is an immediate result of stress[10]. This stress may increase the likelihood of developing lifestyle problems such as hypertension and diabetes mellitus in the future. The CPT is a straightforward method used to assess the stress response of the left ventricle [11]. Kasagi et al. found that higher CPT responsiveness is a predictor of prospective hypertension[12]. Carroll et al. conducted a study which demonstrated that both systolic and diastolic BP rose in response to CPT[13].Park et al. found that overweight people had a heightened response in postganglionic sympathetic nerve activity to CPT.

MATERIAL AND METHODS

This research was conducted for a duration of 12 months at the Department of Physiology. The research recruited 80 volunteers between the ages of 18 and 30 years with a body mass index (BMI) ranging from 18 to 30 kg/m2.
Individuals who had a history of smoking, alcohol usage, drug intake, any systemic ailment, or a bone injury in their dominant hand were not included in the research.

METHODOLOGY

The current observational research was carried out using a sample size of 80 participants. This investigation commenced subsequent to obtaining clearance from the Institutional Ethical Committee. Prior to commencing the research, written informed consent was acquired from every participant. Prior to monitoring blood pressure, the participant was instructed to sit in a comfortable position for a duration of 5 minutes. The cuff was fastened securely around the dominant upper arm, about 2-3 cm above the elbow. Next, the stethoscope's bell was gently placed above the brachial artery and the air pump was compressed, causing the mercury level to rise to 40-50 mmHg above the systolic level obtained by the palpatory approach. The pressure was gradually reduced until a distinct rhythmic sound was detected, and the blood pressure was measured using the auscultatory technique.The subject's dominant arm was submerged in icy cold water and within one minute, systolic and diastolic blood pressure were recorded.

STATISTICAL ANALYSIS

The statistical analysis was conducted using an independent samples t-test in SPSS version 21. A significance level of $P < 0.05$ was used to determine statistical significance.

RESULTS

Table 1 displays the average age of the participants as 26.32±3.54yrs, their weight as 76.87±6.89kg, and their height as 1.61±0.29m.

Table 1: Basic parameter of the participants

	Number =80	Percentage
Age		
Below 20	**14**	**17.5**
20-25	**54**	**67.5**

25-30	12	15
Mean Age(years)	**26.32±3.54**	
Height(meters)	1.61±0.29	
Weight(kilograms)	**76.87±6.89**	

Table 2: Comparison of SBP in different group of BMI before and after sympathetic stimulation by using CPT (n=80)

	CPT - SBP(Grouped)			Total
BMI	**Normal**	**Pre-hypertension**	**Stage I Hypertension**	
Normal	12	37	1	50
Overweight	1	9	1	11
Obese	2	11	6	19
	15	57	8	80

Table 2 shows the comparison of SBP in different groups of BMIbefore and after sympathetic stimulation by CPT. With normal BMI, 12 subjects were normal SBP, 37 subjects were pre-hypertensive and 1 subject was stage 1 hypertensive. In overweight, 1 subject was normal ,9 subjects were pre-hypertensive and 1 subject was stage 1 hypertensive. In obese, 2 subjects were normal, 11 were pre-hypertensive and 6 subjects were stage 1hypertensive.

Table 3: Comparison of DBP in different group of BMI before and after sympathetic stimulation by using CPT(n=80)

		CPT- DBP(Grouped)			Total
BMI	**Normal**	**Pre-hypertension**	**Stage I Hypertension**	**Stage II Hypertension**	
Normal	16	31	3	0	50
Overweight	2	7	2	0	11
Obese	3	6	8	2	19
Total	21	44	13	2	80

Table 3: shows the comparison of DBP with different groups of BMI before and after sympathetic stimulation by CPT. With normal BMI, 16 subjects were normal DBP, 31 subjects were pre- hypertensive and 3 subjects were stage 1 hypertensive. In overweight, 2 subjects were normal, 7 subjects were pre- hypertensive and 2 subjects were stage 1 hypertensive. In obese, 3 subjects were normal, 6 subjects were pre-hypertensive, 8 subjects were stage 1 hypertensive and 2 subjects were stage 2 hypertensive.The association of body mass index with blood pressure after sympathetic stimulation by cold pressor test in 80 volunteer subjects. The findings of this study are sympathetic activity was increased in overweight and in obese as compared to normal body mass index after CPT.

DISCUSSION

The primary factors contributing to an elevated BMI are a lack of physical activity and an imbalance between calorie consumption and energy expenditure. Nowadays internet-based treatments (viewing movies, playing video games and browsing the internet) also lowers physical activity to a large amount. Obesity and overweight have been identified as the primary factors contributing to hypertension. The Framingham Study found that a 10 percent rise in body mass index is associated with a 7 mmHg increase in systolic blood pressure in the general population [15].

In research conducted by Bramlage P et al. in 2004, it was shown that obese subjects consistently had increased blood pressure values. The prevalence of normal BMI subjects was 34.3%, overweight subjects accounted for 60.6%, 1st grade obesity was seen in 72% of the population, 2nd grade obesity in 77.1%, and 3rd grade obesity in 74.1%[16].

In addition, we observed that overweight and obese individuals had higher blood pressure levels compared to those with normal weight. In 2014, Nayak M et al. found that adult men had a more pronounced positive correlation between BMI and autonomic reactivity compared to females. In the younger population, there is a correlation between body mass index and autonomic reactivity, which is not seen in the middle-aged population. The measurement of Sympathetic activity was conducted using the cold pressure test[17].In this investigation, we found a correlation between body mass index and autonomic reactivity in young adult males, which aligns with the findings of Nayak M et al. Following the administration of sympathetic stimulation via the cold pressure test, blood pressure was shown to be elevated in those who were fat. Santos FDD et al. performed a study on a sample of 166 adolescents aged 14-17, including both males and females. Located in the province of Pernambuco, Brazil, is Triunfo Public School. It was noted that adolescents with a greater BMI had notably higher systolic blood pressure (SBP), whereas in both males and females, both SBP and diastolic blood pressure (DBP) were considerably higher following the cold pressor test (CPT) [18].

In their research, Rodriguez-Colon et al. [19]

discovered that 12.3% of the children were classified as obese. The researchers conducted a comparison of the impact of BMI, height percentiles, weight percentiles, and waist circumference on heart rate variability. They discovered a significant correlation between weight and heart rate variability.

Oliveira et al.[20] examined the correlation between several variables and the autonomic regulation of the cardiovascular system in a group of 64 obese individuals. Obese individuals had a higher degree of sympathetic autonomic regulation. A negative correlation was observed between high frequency and the assessment model. Additionally, they observed a detrimental correlation between the sympathetic component and high-intensity physical exercise. There was a negative correlation between high frequency and waist circumference, as well as Homeostasis Model Assessment - Estimated Insulin Resistance (HOMA-IR) scores. The researchers determined that obese individuals had significant changes in cardiac autonomic regulation, which were primarily impacted by central obesity and insulin resistance.

According to Indumathy et al.[21], obese individuals have a higher presence of markers indicating an imbalance in the sympathetic and vagal nervous systems (sympathovagal imbalance or SVI) compared to non-obese individuals. The individuals who were obese had a decrease in parasympathetic activity and an increase in sympathetic activity. The indicators of SVI showed a correlation with lipid risk factors, high sensitivity C reactive protein (hsCRP), homeostatic model assessment of insulin resistance (HOMA-IR), and anthropometric indices.

Yadav et al.[22] found that obese individuals had a considerably higher average heart rate, but lower heart rate variability markers. A strong positive connection was seen between low frequency and waist-hip ratio. There found a negative correlation between it and high-frequency power. The relationship between BMI and heart rate variability did not show any statistically significant link.

Rossi et al.[23] discovered that obese individuals had a notably decreased heart rate response during deep breathing in comparison to non-obese individuals. In addition, they had a markedly reduced heart rate response to the cross-correlation test in comparison to those who were not fat.

Quilliotet al.[24] observed that persons who were obese or overweight showed considerably reduced variability in normalized low-frequency (LF) spectral analysis of both heart rate (HR) and blood pressure (BP) compared to their control group. A negative connection was observed between BMI and normalized LF spectral analysis, after controlling for age. Our research included 80 male volunteers aged between 18 and 30 years. The systolic blood pressure (SBP) and diastolic blood pressure (DBP) showed a substantial rise in the teenage participants after sympathetic activation induced by the cold pressure test.

CONCLUSION

After doing the Cold pressor test, we determined that there was an increase in sympathetic activity among those who were overweight or obese compared to those with a normal body mass index.

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