ORIGINAL RESEARCH

The association between obesity and the functions of the autonomic nervous system in young adults

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ABSTRACT:
Background:Due to anticipated increases in blood pressure correlated with BMI, it is projected that a substantial number of additional cases of myocardial infarctions and strokes will occur due to the connection between hypertension and cardiovascular risk.**Methods**:Blood pressure, Cold pressure test and body mass index of the subject (n=240, age =18-25 years) was recorded following standard procedure. The blood pressure was recorded by auscultatory method. The dominating arm of the subjects was immersed in the cold water and after that immediately within 1 minute systolic and diastolic blood pressure was measured.**Results**:The study reveals that sympathetic activity significantly increased in individuals with overweight and obesity compared to those with a normal body mass index following the cold pressor test.**Conclusion**:Following the Cold Pressor Test, it was observed that sympathetic activity increased in overweight and obese subjects in comparison to those with a normal body mass index.
Keywords: Blood Pressure, Body mass index, Cold pressor test.

INTRODUCTION

The escalating prevalence of overweight and obesity on a global scale, impacting approximately one-third of the world's population, signifies a critical and complex public health issue. Contributing to this phenomenon are multifaceted factors, encompassing not only the traditional culprits of physical inactivity and an imbalance between calorie intake and energy expenditure but also the contemporary sedentary lifestyles associated with widespread internet-based activities. This evolving landscape poses a substantial challenge to maintaining optimal health.This surge in obesity has profound implications, notably an increased susceptibility to hypertension, a condition intricately linked to cardiovascular health.[1] The seminal Framingham Study provides empirical evidence, establishing a direct association between a 20 percent elevation in body mass index and a consequential 7 mmHg rise in systolic blood pressure within the general population. Such findings underscore the urgent need to comprehend the intricate interplay between weight status and cardiovascular risk.In the realm of cardiovascular assessment, the Cold Pressor Test (CPT) emerges as a valuable tool. By subjecting individuals to discomfort and measuring their physiological responses, the CPT not only offers insights into stress-related autonomic cardiovascular function but also serves as an indicator of potential hypertension risk. This non-invasive test illuminates the immediate consequences of stress, particularly the stimulation of the sympathetic nervous system, providing clinicians and researchers with a window into the complex dynamics of the body's response to stressors.Studies conducted by Kasagi, Carroll, and Park contribute significantly to our understanding of the predictive value of CPT reactivity in identifying potential hypertension. This underscores the importance of comprehensively assessing stress responses and their implications for cardiovascular health. Acknowledging the intricate relationship between stress, obesity, and cardiovascular outcomes is paramount in devising holistic strategies aimed at mitigating the global burden of lifestyle-related disorders. As we delve deeper into these connections, we equip ourselves with the knowledge needed to develop targeted interventions and promote public health initiatives

that address the root causes of this pervasive health challenge.

The primary role of the autonomic nervous system (ANS) is to maintain internal homeostasis by overseeing visceral functions. A vast array of internal processes falls under the regulatory purview of the ANS, and its functioning is intricately linked to somatosensory inputs from diverse regions of the body. The ANS is bifurcated into the sympathetic and parasympathetic nervous systems, operating independently yet engaging in reciprocal interactions to finely tune organ functions. Often characterized as the "fight or flight" system, the sympathetic system prepares the body for strenuous activities, while the parasympathetic system, known as the "feed or breed" system, fosters restorative processes.Various physiological conditions, including age, sex, race, and environmental factors, exert influences on the ANS and, consequently, on the regulation of bodily functions. Notably, the sympathetic and parasympathetic systems play pivotal roles in orchestrating responses to internal and external stimuli, ensuring a dynamic equilibrium.[2]In the context of aging, the impact of age-related autonomic dysfunction on cardiovascular (CV) regulatory control is particularly noteworthy. A significant proportion of deaths among the elderly is attributed to cardiovascular disorders, constituting a third of elderly mortality. Notably, sudden death and lethal ventricular arrhythmias account for 50% of these cardiovascular-related deaths. The compromised regulatory control of the autonomic nervous system in the elderly is recognized as a contributing factor to the heightened incidence of cardiovascular dysfunctions in this demographic.Understanding the intricate interplay between the autonomic nervous system, aging, and cardiovascular health is crucial for devising targeted interventions and preventive strategies. It illuminates the underlying mechanisms that contribute to the vulnerability of the elderly population to cardiovascular disorders, providing a foundation for developing approaches to enhance autonomic function and mitigate associated risks. As the scientific community delves deeper into these connections, there emerges an opportunity to improve the quality of life for the aging population and reduce the burden of cardiovascular-related morbidity and mortality in this demographic.

Previous research has consistently identified exaggerated cardiovascular reactivity in individuals with obesity, positioning it as a potential risk factor for hypertension. However, it's noteworthy that these studies primarily focused on adolescents, leaving a gap in understanding how gender and body mass index (BMI) collectively impact autonomic functions in young adults and middle-aged individuals within the Indian population.[3] To bridge this knowledge gap, the current study has been designed with the specific objective of evaluating the influence of BMI on autonomic reactivity tests in both males and females across these two distinct age groups.By extending the investigation beyond adolescence to encompass young adults and middle-aged individuals, the study aims to provide a more comprehensive understanding of the nuanced relationship between BMI, gender, and autonomic functions. This research is crucial for gaining insights into how cardiovascular reactivity may evolve with age and gender, shedding light on potential variations in autonomic responses within the context of body mass index.

The outcomes of this study have the potential to contribute significantly to our understanding of cardiovascular health and risk factors in the Indian population.[4] By pinpointing the interplay between BMI, gender, and autonomic functions in different age groups, the research may inform targeted interventions and preventive strategies for managing hypertension and related cardiovascular conditions. This study not only addresses a current research gap but also holds promise for advancing our knowledge of cardiovascular health in diverse demographic segments, fostering more effective and personalized approaches to healthcare.Dysautonomia, a term used to characterize the condition leading to dysfunction in the autonomic nervous system (ANS), encompasses a spectrum of disorders that impact various involuntary bodily responses. The autonomic nervous system plays a pivotal role in regulating key functions such as heart rate, digestion, bladder function, sweating, and blood pressure. When dysautonomia is present, these processes can be adversely affected, resulting in a range of symptoms and complications.[5]This condition is not limited to a single disorder but has been identified in various inherited diseases, broadening its clinical manifestations. Notable examples of conditions where dysautonomia is featured include Parkinson’s disease, multiple system atrophy, and autonomic neuropathy. In these cases, the dysfunction of the autonomic nervous system contributes to the complexity of the overall disease presentation, influencing both motor and non-motor aspects of these disorders.Diagnosing dysautonomia involves specialized functional testing of the autonomic nervous system, with a keen focus on the specific organ systems affected. This diagnostic approach allows healthcare professionals to discern the extent and nature of autonomic dysfunction, aiding in the identification of the underlying causes and contributing factors. By targeting the affected organ systems, clinicians can tailor treatment plans and interventions to address the unique challenges presented by dysautonomia in each individual case.In essence, dysautonomia serves as a comprehensive term encapsulating the disruption of autonomic nervous system functionality, and its presence in various inherited diseases emphasizes its role as a significant contributor to the complexity of these medical conditions.[6] The ongoing advancement in diagnostic techniques and understanding of dysautonomia holds promise for improved

management and targeted interventions, ultimately enhancing the quality of life for individuals grappling with autonomic dysfunction.

MATERIALS AND METHODS

This 12-month observational study was conducted with a targeted approach, incorporating specific inclusion and exclusion criteria to refine the participant group under investigation. The inclusion criteria focused on volunteers within the 18-25 years age range and with a Body Mass Index (BMI) falling between 18 and 30 kg/m².[7] This age-specific and BMI-restricted selection aimed to provide a homogeneous study population for more precise analysis. Exclusion criteria were meticulously designed to eliminate potential confounding factors, excluding individuals with a history of smoking, alcohol or drug consumption, any systemic illness, and bone injuries in the dominating hand. By implementing these stringent criteria, the study sought to ensure a controlled environment for observing and analyzing relevant health parameters over the course of the 12-month study duration. This approach enhances the reliability and specificity of the study outcomes, contributing to a more nuanced understanding of the targeted age group's health dynamics.

This observational study involved 240 volunteers and commenced following the approval of the Institutional Ethical Committee. Prior to the initiation of the study, written informed consent was diligently obtained from each participant to ensure ethical standards were upheld throughout the research process.[8] The measurement procedures included the assessment of blood pressure and the Cold Pressor Test. Before these measurements, participants were instructed to sit comfortably for a 5-minute resting period. The blood pressure cuff was securely fastened around the dominating upper arm, positioned 2-3 cm above the brachial artery. Using a stethoscope, the bell was gently pressed above the brachial artery, and the air pump was compressed until the mercury level reached 40-50 mmHg above the systolic level, determined through the palpatory method. Subsequently, pressure was gradually released until a distinct beating sound was audible, and blood pressure was recorded using the auscultatory method.[9]

Following the blood pressure measurement, the participant's dominating arm was immersed in cold water (20°C), and within the ensuing minute, systolic and diastolic blood pressures were promptly measured. This comprehensive approach to data collection ensured a standardized and meticulous procedure, essential for the accurate evaluation of the participants' physiological responses to the Cold Pressor Test. The systematic and ethical conduct of the study, including participant consent and adherence to approved protocols, contributes to the robustness and reliability of the research findings.

RESULTS

Table 1: Comparison of SBP in different group of BMI before and after sympathetic stimulation by using CPT (n=240)

		CPT SBP(Grouped)			Total
		Normal	Pre-hypertension	Stage I Hypertension	
BMI	Normal	34	102	4	140
	Overweight	2	26	4	32
	Obese	4	46	18	68
Total		40	174	26	240

Table 1 presents a comprehensive comparison of systolic blood pressure (SBP) across distinct body mass index (BMI) groups before and after exposure to sympathetic stimulation through the Cold Pressor Test (CPT). Among individuals with a normal BMI, the distribution revealed 34 subjects with normal SBP, 102 subjects in the elevated pre-hypertensive category, and 4 subjects classified as stage 1 hypertensive.[10] In the overweight category, 2 subjects exhibited normal SBP, 26 subjects fell into the elevated pre-hypertensive range, and 4 subjects were categorized as stage 1 hypertensive. The obese group displayed 4 subjects with normal SBP, 46 subjects in the elevated pre-hypertensive range, and 18 subjects categorized as stage 1 hypertensive. This breakdown underscores the varied distribution of blood pressure levels within different BMI classifications, providing valuable insights into the potential impact of sympathetic stimulation on blood pressure responses across diverse weight categories. The findings contribute to our understanding of the complex interplay between BMI and sympathetic activation in influencing cardiovascular parameters.

Table 2: Comparison of DBP in different group of BMI before and after sympathetic stimulation by using CPT (n=240)

		CPT DBP(Grouped)				Total
		Normal	PreHypertension)	Stage I Hypertension	Stage II Hypertension	
BMI	Normal	48	84	8	0	140
	Overweight	4	24	4	0	32
	Obese	10	38	14	6	68

Total	62	146	26	6	240

Figure1: Comparison of DBP in different group of BMI before and after sympathetic stimulation by using CPT

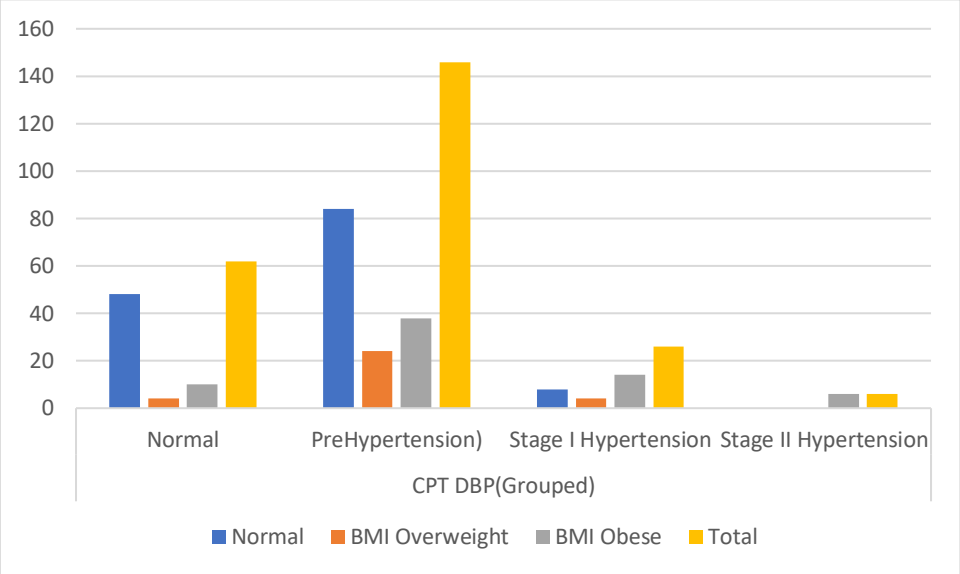

Table 2 and figure1 details the comparative analysis of diastolic blood pressure (DBP) among various body mass index (BMI) groups, both before and after sympathetic stimulation induced by the Cold Pressor Test (CPT). Within the normal BMI range, the distribution revealed 48 subjects with normal DBP, 84 subjects classified as elevated pre-hypertensive, and 8 subjects categorized as stage 1 hypertensive. Among the overweight individuals, 4 subjects exhibited normal DBP, 24 were in the elevated pre-hypertensive range, and 4 subjects were classified as stage 1 hypertensive. In the obese category, 10 subjects showed normal DBP, 38 subjects fell into the elevated pre-hypertensive range, 14 subjects were categorized as stage 1 hypertensive, and 6 subjects were classified as stage 2 hypertensive.[11]These findings illuminate the nuanced relationship between BMI and diastolic blood pressure responses following sympathetic stimulation. Notably, the study's overarching observation indicates increased sympathetic activity in overweight and obese individuals compared to those with a normal BMI after exposure to the Cold Pressor Test. This insight contributes to our understanding of the complex interplay between body mass index and autonomic responses, shedding light on potential implications for cardiovascular health within distinct weight categories. The comprehensive nature of this analysis involving 240 volunteer subjects enhances the reliability and applicability of the study's outcomes.

DISCUSSION

The study conducted by Bramlage et al.[12]in made a notable observation regarding consistently elevated blood pressure (BP) levels in obese participants. The distribution across various BMI categories highlighted this trend, with normal BMI subjects at 34.3%, overweight subjects at 60.6%, grade 1 obesity at 72%, grade 2 obesity at 77.1%, and grade 3 obesity at 74.1%. Our findings echo this trend, indicating increased blood pressure levels in overweight and obese participants compared to those with a normal weight. This aligns with the established link between BMI and hypertension, emphasizing the importance of weight management in cardiovascular health.

Nayak et al.'s[13] study emphasized a stronger positive association between BMI and autonomic reactivity in adult males compared to females. Our study aligns with this observation, particularly in young male adults, where the body mass index demonstrated a direct correlation with autonomic reactivity. The application of the cold pressure test to measure sympathetic activity revealed a notable increase in blood pressure in obese subjects, reinforcing the connection between BMI and autonomic responses.Santos et al.'s research on adolescents further supports the correlation between BMI and blood pressure reactivity.[12-14] Their findings, showing significantly higher systolic and diastolic blood pressure after the cold pressor test in adolescents with a higher BMI, align with our study's observations in young adults. Together, these studies underscore the importance of understanding the relationship between BMI and autonomic responses, especially in the context of cardiovascular health, providing valuable insights for preventive interventions and health management strategies.

In our study, which comprised 240 male participants within the age range of 18-25 years, notable observations were made regarding the impact of sympathetic stimulation induced by the cold pressor test on systolic blood pressure (SBP) and diastolic

blood pressure (DBP). Following the sympathetic activation, both SBP and DBP exhibited a significant increase in the adolescent subjects.This finding aligns with existing research that highlights the influence of sympathetic stimulation on blood pressure parameters, particularly in the context of autonomic reactivity.[15] The cold pressor test, a well-established method for inducing sympathetic activation, proved effective in revealing the heightened response of both SBP and DBP in our cohort of young male participants.These results contribute to the broader understanding of autonomic responses and their implications for cardiovascular health in the specific demographic of young adult males. The identification of significant increases in both SBP and DBP following sympathetic stimulation underscores the relevance of considering autonomic reactivity in assessing cardiovascular dynamics among this particular age group. Such insights may inform targeted interventions and preventive strategies aimed at managing blood pressure fluctuations in young adults, contributing to the overall promotion of cardiovascular well-being.

The research conducted by Higashi et al. highlights the significant association between menopause, hypertension, and endothelial dysfunction, suggesting their roles as potential risk factors for coronary heart disease. Endothelial dysfunction, characterized by impaired blood vessel function, is a critical factor in the pathogenesis of cardiovascular diseases. Both menopause and hypertension contribute to this dysfunction, amplifying the risk of coronary heart disease. This study sheds light on the intricate relationship between hormonal changes and cardiovascular health.[16]Moreover, investigations into the autonomic nervous system have revealed that baroreceptor control of heart rate (HR) undergoes alterations during the regular menstrual cycle. Notably, estradiol, a key estrogen hormone, is identified as a modulator of cardiovascular function, exerting a more pronounced effect on HR modulation in women compared to age-matched men. Interestingly, these gender-related autonomic differences seem to diminish in the middle-aged group, suggesting a dynamic interplay between hormonal influences and age-related changes in cardiovascular regulation.

These findings contribute to our understanding of the complex interactions between hormonal dynamics, autonomic control, and cardiovascular health. Recognizing the impact of menopause, hypertension, and gender-specific hormonal influences on endothelial function and autonomic control provides valuable insights for developing targeted strategies in preventing and managing cardiovascular diseases, particularly in populations at risk.[17]

The primary discovery of this study is the noteworthy elevation in Body Mass Index (BMI) observed in younger males, potentially leading to adverse effects on cardiovascular (CV) autonomic parameters during adulthood.[18] This contrast in BMI-related effects was not observed in females, hinting at the potential protective effects of estrogen. Estrogen, a hormone predominantly present in females, is known to exert beneficial effects on cardiovascular health. The absence of adverse CV effects in females might be attributed to the cardioprotective properties of estrogen.However, it'sessential to note that as subjects transition into middle age, the gender differences in autonomic and cardiovascular dysfunctions seem to diminish.[19] This attenuation of gender-specific differences could be attributed to a combination of factors, including the natural aging process and the decline in estrogen levels. Aging is often associated with changes in autonomic function, and the decline in estrogen, particularly seen in postmenopausal women, may contribute to alterations in cardiovascular dynamics.These findings highlight the intricate interplay between age, gender, hormonal influences, and cardiovascular health. The protective effects of estrogen in females, especially in the context of autonomic parameters, appear to diminish with age and declining estrogen levels. Understanding these dynamics is crucial for tailoring interventions and preventive measures, particularly in addressing cardiovascular risk factors associated with BMI in younger males and accounting for hormonal influences across different stages of life.

CONCLUSION

The present study focused on a cohort of 240 healthy young male adults aged between 18 and 25 years. The primary objective was to explore the association between body mass index (BMI) and sympathetic function in this specific demographic. Through the utilization of the Cold Pressor Test, the study aimed to evaluate sympathetic activity and its potential correlation with BMI in young male adults.The key findings of this investigation revealed a noteworthy increase in sympathetic activity among individuals classified as overweight and obese when compared to those with a normal BMI following the Cold Pressor Test. This suggests that higher BMI levels are associated with heightened sympathetic responses, providing valuable insights into the autonomic regulation of cardiovascular function in the context of weight status among young male adults.These findings contribute to the growing body of knowledge surrounding the intricate relationship between BMI and sympathetic function, emphasizing the importance of understanding autonomic dynamics in the context of cardiovascular health. The study lays a foundation for further research and may have implications for targeted interventions aimed at mitigating potential cardiovascular risks associated with elevated BMI in young male populations.

REFERENCES

1. Finkelstein EA, Kaviou OA, Thompson H, Trogdon JG, Pan LP, Shery B, et al. Obesity and severe obesity forecasts through 2030. Am J Prev Med. 2012;2,42(6):563-70.

2. Wafa SW, Talib RA, Hamzaid NH, McColl JH, Rajikan R, Ng LO et al. Randomized controlled trial of a good practice approach to treatment of childhood obesity in Malaysian Childhood Obesity Treatment Trial (MASCOT), Int J Pediatr obese 2011; 6(2):62-69.
3. Kannel WB. Risk stratification in hypertension: new insight form the Framingham study. Am J Hypertens. 2000;1-2:3-10.
4. Reaven GM, Laws A. Insulin resistance, compensatory hyperinsulinaemia, and coronary heart disease. Diabetologia. 1994;37(9):948-52.
5. Hall JE, Louis K. Dahl Memorial Lecture. Renal and cardiovascular mechanisms of hypertension in obesity. Hypertnsion. 1994; 23(3):381-94.
6. Ashley FW jr, Kannel WB. Relation of weight change to changes in aterogenic traits: the Framingham study. J Chronic Dis. 1974; 27(3):103-4.
7. Wood DL, Sheps SG, Eleback LR, Schirger A. Cold pressor test as a predictor of hypertension. Hypertension. 1984; 6(3):301-6.
8. Zhao Q, Bazzano LA, Cao J, Li J, Chen J, Huang J et al. Reproducibility of blood pressure response to the cold pressor test: The Gen Salt Study. Am J Epidemiol. 2012; 176 (7): 91-8.
9. Northcote RJ, Cooke MB. How useful are the cold pressor test and sustained isometric handgrip exercise with radionuclide ventriculography in the evalution of patients with coronary artery disease? Br Heart J. 1987; 57(4):319-28.
10. Kasagi F, Akahoshi M, Shimaoka K. Relation Between cold pressor test and development of hypertension based on 28 year follow-up. Hypertension. 1995; 25:71-76.
11. Carroll D, Smith D, Willemsen G, Sheffield D, Sweetnam PM, Gallacher JE et al. Blood pressure reaction to the cold pressure test and prediction of ischaemic heart disease: data from the caerphilly study. J Epidemiol Community Health. 1998; 52(8):528-29.
12. Park J,Middle Kauff HR,CampeseVM.Abnormal sympathy- etic reactivity to the cold pressor test in overweight humans AM J. Hypertens. 2012; 25(12):1236-41.
13. Misra A, Chowbey P, Makkar BM, Vikram NK, Wasir JS, Chadha D et al. The metabolic syndrome for Asian Indian and recommendation for physical activity, medical and surgical management. J Assoc Physicians India. 2009; 57: 163 -70.
14. Arora SK, Kumar M, Verma A. Cardiovascular reactivity in young adults with hypertensive and normotensiv parents: Agender based comparative study. Acta Med Int. 2017; 4(1):101-9.
15. Ghai CL. Textbook of practical physiology. Jaypee Brothers Medical Publishers. New Delhi | London | Panama. 9th edition 2019:140-46.
16. Jain AK. Manual of Practical Physiology for MBBS. Arya publications 6th edition. 2019, 285-86.
17. Bramlage P, Pittrow D, Wittchen HU,Kirch W, Boehler S, Lehnert H et al. Hypertension in overweight and obese primary Care Patients is highly prevalent and poorly controlled. AJH. 2004; 17(10):904-10.
18. Nayak M, Ray N. Influence of gender and body mass index on autonomic reactivity in adults and middle aged population. Int J ClinExp Physiol. 2014; 1(4):303-6.
19. Santos FD, Pinto EF, Moura ARLI, Lima EVC, Souza MF, Carvalho FO, Moraes JFVN. RevistaCiencias EM Saude. Helth Sci J. 2020; 10(3): 109-15