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THE EFFECTS OF BODY MASS INDEX ON BLOOD PRESSURE IN AN APPARENTLY HEALTHY INDIVIDUALS

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Background	The association between BMI and BP has important health implications, and will become an even more dominant health challenge as BMI continues to increase. An increasing BMI has a changing trends in elevated BP levels. There seen a consistency in the findings of relationship between BMI and elevated BP in several studies.
Objectives	To evaluate the association between body mass index (BMI) and cardiovascular parameters with age & sex matched healthy individuals.
Methodology	The study was conducted at PG Laboratory, Physiology department, Government medical college, Vadodara. Body weight and height was measured, BMI was calculated using the formulae (kg/m^2). Blood Pressure was measured using Sphygmomanometer, in sitting position. According to JNC-7^{th} guidelines, classified into normal, pre-hypertensive and hypertensive.
Results	Among the 150 subjects, based on the BMI, 3 groups were formed, 50 belonged to category A (BMI < 25), 50 belonged to category B (BMI 25 to 30), and 50 belonged to category C (BMI>30). In overweight and obese category, the SBP is above 130 mmHg, a stage of pre-hypertension is noted, and increase in SBP, PP & MAP in all the three categories. A positive correlation between BMI and SBP in the overweight and obese category, and also the same correlation is seen with DBP, PP, MAP & PR.
Conclusion	In my study, the overweight and obese categories can be grouped in the pre-hypertensive stage compared to the normal BMI group, in accordance with JNCCP guidelines. Obesity is a double tragedy, hypertension and

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	metabolic abnormalities interact and potentiate their individual impact on cardiovascular risk.
Key words	BMI-body mass index, SBP-systolic blood pressure, DBP-diastolic blood pressure, PP-pulse pressure, MAP-mean arterial pressure, PR-pulse rate.

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INTRODUCTION:

According to the World Obesity Atlas 2023, the number of people with overweight and obesity is projected to increase from over 2.6 billion in 2020 to over 4 billion by 2035, showing a rise from 14 % to 24%. The predictions for India too are dire. There has been a dramatic rise in the prevalence of obesity over the past few years. The consequences of obesity on health are well-established.

Obesity has a significant social and emotional effects. The Framingham Offspring Study, categorized CVD risk factors into modifiable and non-modifiable risk factors [(1)]. Excess accumulation of fat in the body predisposed to early atherosclerosis of blood vessels, resulting in Coronary Artery Diseases (CAD) and the risk is stratified if comorbidities like Diabetes Mellitus and Systemic Hypertension.

Biochemical and research studies have suggested that, the excess fat accumulation, leading to activation of both sympathetic nervous system and renin-angiotensin system, resulting in elevated blood pressure [(2).] The aim and objective of my study is to correlate the association between three categories of Body Mass Index (BMI) and systolic blood pressure, diastolic blood pressure, pulse rate.

MATERIALS AND METHODS:

The present study was carried out, after, getting permission from the Institutional Ethics Committee for Human Research-PG Research (IECHR-PG). Participants in our study were health care workers from SSG Hospital, Vadodara and further divided into three categories according to BMI.

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All the subjects were explained about the effect of BMI, and an informed consent was taken after explaining about the tests to be done in local language. Detailed history taking include personal information like name, age, socioeconomic status, past history, personal and family history. Followed by general examination, vitals such as pulse rate, blood pressure, respiratory rate has been recorded and systemic examination was done for all subjects.

The body weight was measured with the participant standing erect and without shoes and the height was measured with participant standing erect on the floor with the buttocks, shoulders and back of the head touching the wall. The lower border of the orbit was held in the same horizontal plane as the external auditory meatus. The arms was hanging freely by the side of the body.

The BMI was calculated with the formula (kg/m^2), weight (kg) divided by the square of height (m2).

Blood pressure is the lateral pressure exerted on the wall of the arterial vessels by the contained blood. Systolic blood pressure (SBP) is the maximum pressure during systole. The normal value is (100-120mmHg). Diastolic blood pressure (DBP) is the minimum pressure during diastole. The normal value is 70-80mmHg. As per JNC 7^{TH} report guidelines, Normal: < 120/80 mm Hg, Pre-hypertensive: 130-139/80-89 mm Hg, Hypertensive (Stage 1 and Stage 2) : >140/90 mm Hg.

After 5 minutes of rest, in sitting position, BP was measured by Sphygmomanometer in the left upper arm, by palpatory and auscultatory method. To avoid errors, three readings each about two minutes apart and average was taken as final reading. In-between measuring the BP, the cuff pressure is lowered to zero.

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Inclusion criteria: According to WHO 2017 guidelines, people with BMI 18.50 – 24.99 kg/m2, ≥25kg/m² and ≥ 30 kg/m2 in the age group of 25-40 years without a known cardiac disease were included in the study.

Exclusion criteria: Subjects having ≤25 years of age or ≥40 years of age and with medical problems like cardiorespiratory illnesses, hypertension, diabetes mellitus, and endocrine problems was excluded from this study. Specific cardiac pathology such as Q waves, Bundle Branch Block (BBB), ST-T elevation or depression, atrial fibrillation or atrial flutter in the ECG were not included in the study.

RESULTS:

In this study, a total number of 150 subjects were evaluated. Out of that, 56 belonged to 21-30 years age group and 94 belonged to 31-40 years age group Further, out of the 150, based on the BMI, 3 groups were formed, 50 belonged to category A (BMI < 25), 50 belonged to category B (BMI 25 to 30), and 50 belonged to category C (BMI>30) (Table-1). Table-2, shows the number of male and female subjects in each category, out of 150, 93 were males and the rest 57 were females.

DISCUSSION:

Obesity has an important role in hemodynamic and non-hemodynamic mechanism such as diastolic dysfunction, autonomic nervous system imbalance, endothelial injury, insulin resistance and increased systemic inflammation.

In our study, the mean SBP is 122.83±9.99 in category C, 122.84±8.94 in category B, and 116 ±8.84 in category A (Table: 3). In overweight and obese category, the SBP is above 130 mmHg, a stage of pre-hypertension is noted, whereas DBP comes under normal range in all the three

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categories. Overweight subjects had a significantly higher systolic blood pressure compared with subjects in the other quartiles of BMI and also subject with lower BMI quartiles had a significantly lower systolic blood pressure.

The MAP is 88.03±6.17 in normal BMI, 94.88±6.85 in overweight, and 95.43±6.44 in obese category, and there found to be a statistically significance between the categories. The mean PP is 42 ± 7.5 in obese category, with no statistical significance among the categories. There is a consistent increase in SBP, PP and MAP was found in overweight and obese category. The reason could be due to increased body weight and body fat that is affecting the microcirculation.

There is a positive correlation between BMI and SBP in the overweight and obese category, and also the same correlation is seen with DBP, PP, MAP & PR respectively (Table:-4). No statistical significance was found except BMI SBP in the obese category. But in similar studies, BMI was positively associated with systolic blood pressure, diastolic blood pressure and pulse rate. A strong correlation was found between high BMI and increasing blood pressure, which is statistically significant as well. The relationship between BMI and SBP/DBP is nearly linear in various studies [(3)] and a cascade of associated metabolic disorders and impaired renal-pressure natriuresis [(4)] .

In contrary to the expectation, the BMI and HR (mean 68.52 ±8.59), has no statistical significance and same values in all the 3 categories, also a negative correlation between BMI and SBP & PR in the normal BMI category A, may be due to dysautonomia, domination of PNS than the SNS activity (Table:-3 & 4). In the MyHEART study, an inverse association between BMI and HR among apparently healthy adolescents of both genders [(5)].

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Clinical studies indicate that maintenance of a BMI <25kg/m² is effective in primary prevention of hypertension and that weight loss reduce BP in most hypertensive subjects [6]. Trials for the hypertension prevention, includes weight loss as a tool in primordial prevention [7].

CONCLUSION:

The relationship between obesity and blood pressure is once again proved in this study. The study was carried out in early middle-aged population, emphasizing the importance of weight loss as a primordial prevention for Hypertension and CVD. As health care providers, it is upon us to educate about weight loss and to prevent potential health consequences in terms of mortality and morbidity, undertaking prevention strategies at primary level is essential.

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TABLE: 1

AGE GROUP	Category A	Category B	Category C	Total
21-30	24	19	13	56
31-40	26	31	37	94

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Total	50	50	50	150

TABLE: 2

BMI based grouping of male and female subjects.

SEX	Category A	Category B	Category C	Total
Male	32	29	32	93
Female	18	21	18	57
Total	50	50	50	150

TABLE: 3

COMPARISION OF THE VARIABLES BETWEEN BMI CATEGORIES USING ANNOVA:

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PARAMETERS	CATEGORY A (n=47) MEAN ±SD	CATEGORY B (n=50) MEAN ±SD	CATEGORY C (n=53) MEAN ±SD	p-value
SYSTOLIC BP (SBP)	116.04±8.84	122.84±8.94	122.83±9.99	0.000 S
DIASTOLIC BP (DBP)	76.38± 5.89	81 ± 6.59	81.32± 5.78	0.000 S
PULSE PRESSURE (PP)	39.2 ± 7.14	41.64 ± 5.61	42.08 ± 7.5	0.077 NS
MEAN ARTERIAL PRESSURE (MAP)	88.03 ± 6.17	94.88 ± 6.85	95.43 ± 6.44	0.000 S
PULSE RATE	73.12 ± 8.89	73.86 ± 9.62	74.72 ± 7.04	0.648 NS

NS- Not significant, S-significant

Table-3, shows the mean ± standard deviation (SD) of continuous variable between each categories, ANNOVA test analysis, showed highly significance ($p<0.0001$), between the groups, of SBP, DBP, MAP. PP and Pulse rate shows no statistical significant between each groups

TABLE: 4

CORRELATION BETWEEN SBP, DBP, PR WITH BMI CATEGORIES:

GROUPS	CATEGORY A	CATEGORY B	CATEGORY C

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	Pearson's r value	**p-value**	**Pearson's r value**	**p-value**	**Pearson's r value**	**p-value**
BMI SBP	-0.05	0.74 NS	+0.05	0.74 NS	+0.30	0.02 S
BMI DBP	+0.09	0.57 NS	+0.03	0.86NS	+0.17	0.23 NS
BMI PP	-0.19	0.16 NS	+0.07	0.62 NS	+ 0.07	0.61 NS
BMI MAP	+0.04	0.77 NS	+0.04	0.76 NS	+0.19	0.16 NS
BMI PR	+0.009	0.95 NS	+0.11	0.42 NS	+0.21	0.13 NS

NS- Not significant, S-significant

Table-4, shows the correlation between BP, DBP, and PR with BMI categories, and SBP was found to be statistically significant in the category C.