Scenario of Cardiovascular Function in Obese and Overweight Population of Dehradun Uttarakhand, India

Mohd Abass Dar[1], Nidhi Jain[2], Showkat Ahmad Bhat[3], Neeru Garg[4]

ABSTRACT

Introdcution: The increasing number of overweight and obese individuals is a serious health problem worldwide. Growing evidence had clearly and consistently evidenced that obesity is an essential and direct predictor of Cardio vascular function. Study aimed to observe BMI based variations in cardio vascular parameters in overweight and obese individuals.
Material and Methods: The study was carried out on 320 (18-25 years) subjects in district Dehradun of Uttarakhand, India. Different anthropometric parameters and cardiovascular parameters were measured by proper procedures.
Results: The anthropometric parameters weight and height were found statistically significant ($p < 0.05$) among all subjects. BMI based and gender based comparison of cardiovascular parameters (Pulse, SBP, DBP & MAP) were found statistically significant ($p < 0.05$). The correlation of BMI with MAP was found statistically very highly significant. The correlation coefficient (r) between BMI with MAP was found =0.31, denotes partial positive correlation.
Conclusion: Our study concluded that on increasing BMI, the MAP was increased, which may be due to the excess weight that stimulates sympathetic activation and also that probably insulin and leptin are involved. It can be suggested that activation of the rennin angiotensin system as well as physical compression of kidney may be important factors in linking body weight and elevated blood pressure.

Keywords: Cardio Vascular, Obese, Anthropometric Parameters, Body Mass Index

INTRODUCTION

Obesity stands out as an emerging global public health challenge that is epidemically increasing in both developed & underdeveloped countries. According to the recent report, India ranks the second highest number of obese children in the world, with 14.1 million reported cases.[1] Obesity is the state of excess adipose tissue mass. The increasing number of overweight and obese individuals is a serious public health problem that has implications for society and healthcare systems on a global scale. The economic consequences of obesity and associated diseases are not limited to high medical costs but also include indirect or social costs such as decreased quality of life, problems in social adjustment, lost productivity, disability associated with early retirement, and death.[2] As obesity is a key risk factor in natural history of many chronic and non-communicable diseases. The adverse effects of obesity to emerge in population in transition are hypertension, hyperlipidaemia and glucose intolerance, while coronary heart disease and long term complications of diabetes, such as renal failure begin to emerge several years or decades later.[3] Although not a direct measure of adiposity, the most widely used method to gauge obesity is the body mass index (BMI), which is equal to weight/height^2 (in kg/m^2). Obesity is associated with a state of chronic systemic inflammation that is driven predominantly by the action of substances released by adipose tissue. Chronic inflammation is caused by activation of the innate immune system, which promotes a pro-inflammatory state and oxidative stress and a consequent systemic acute-phase response. Systemic inflammation may play a crucial role in the pathogenesis of various obesity-related complications, including metabolic syndrome, Type 2 Diabetes mellitus (T2DM), cardiac disease, liver dysfunction, and cancer.[4] The dysfunction of adipose tissue can induce systemic oxidative stress and lead to abnormal production of adipokines, which contributes to the development of obesity-related disorders. Furthermore, the level of oxidative damage biomarkers is increased in obese individuals and is directly correlated with BMI, percentage of body fat, and levels of triglycerides and low-density lipoproteins.[5] The accumulation of fat, particularly abdominal visceral fat, impairs antioxidant mechanisms.[6] Thus, this study was proposed to observe the change in Body Mass Index (BMI) based variations in cardiovascular parameters in young adults in Dehradun population in the region of Uttarakhand, India.

MATERIAL AND METHODS

The current research was carried out in the Department of Physiology of Shri Guru Ram Rai Institute of Medical and Health Sciences under the umbrella of noble and idealist faculty. The research was carried out on 320 medical students both males and females between the ages of 18-25

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years from various seasonal years of under-graduation. BMI grading of subjects was done according to WHO criteria.[7] It was developed by Adolphe Quetelet.[8]

S. No	Body mass index (BMI)	Interpretation
	18.5 ≤	Underweight
	18.5 – 24.99	Normal weight
	25 – 29.99	Overweight
	30 ≥	Obese

The subjects were firstly divided into four broad groups based on BMI & each group had 2 subgroups:

Group I:	- All Normal weight Subjects - Group I M & Group I F	(80) (40) M & (40) F
Group II:	- All Underweight Subjects - Group II M & Group II F	(80) (40) M & (40) F
Group III:	- All Overweight Subjects - Group III M & Group III F	(80) (40) M & (40) F
Group IV:	- All Obese weight Subjects - Group IV M & Group IV F	(80) (40) M & (40) F

The subjects were further divided into two broad groups (A & B) based on gender.

Group A (160)	Group I M (40)	Group II M (40)	Group III M (40)	Group IV M (40)
Group B (160)	Group I F (40)	Group II F (40)	Group III F (40)	Group IV F (40)

Subject Selection

- All the subjects were physically, socially, mentally fit.
- All the subjects were nonsmoker, nonalcoholic and were not addicted to any habit forming substance.
- Subjects with Cardiovascular disorders (like hypertension) and diabetes mellitus were excluded from the study.
- Approval from college's ethical committee was taken.
- Informed consent was taken from all subjects.
- All subjects were made familiar with the method & equipment prior to test performed.

Anthropometric Parameters:

Age: Age was calculated in years to the nearest birthday.

Height: Height was measured in centimeters (cms) using Stadiometer (Avery Pvt. Ltd.).Calibration of Stadiometer was done using a standardized rod. Stadiometer was checked once in two weeks for any error.

Procedure: Subjects were instructed to stand straight on a flat surface with feet flat, heels almost together, arms at side and looking straight ahead. Heels, hips, shoulder blades and occiput pressing against the vertical bar then the slider were brought down to rest on the top of the head pressing the hair. The arrow accurately measured the height to an accuracy of + 0.5 cm.[9]

Body weight: Body weight was recorded in kilograms, using digital weighing machine Crown Electronic Weighing Machine.

Procedure: The subject was made to stand upright on the scale wearing minimum clothing after taking off his/her shoes. The weight was recorded to an accuracy of + 0.1 kg. The BMI of each subject was obtained mathematically using the formula called as Quetelet formula.[8]

$$BMI = \frac{\text{Body Weight (kg)}}{\text{Height}^2\ (m^2)}$$

Measurement of Cardiovascular Parameters:

- **Blood pressure:** Blood pressure was recorded in mmHg using digital blood pressure monitor (Model REF CH – 432, Citizen System Japan Co. Ltd.).
- **Procedure:** All subjects were allowed to sit down and relax atleast for 15 minutes. To record the blood pressure the subjects' brachial artery was palpated and the centre of the bladder length of the cuff was placed such that it is over the arterial pulsation of the subjects bare upper arm. The lower end of cuff was placed above 2-3 cm above the antecubital fossa.The BP and pulse was recorded in the sitting down position.[10]
- **Pulse rate:** Pulse was taken in **beats/min** in radial artery**.**
- **Mean arterial blood pressure (MAP):** Mean Arterial Pressure (MAP) was calculated from measured systolic blood pressure (SBP) and diastolic blood pressure (DBP) in mmHg by using formula.[11]

MAP = DBP + 1/3 (SBP-DBP) or equivalent

$$MAP = \frac{(2 \times DBP) + SBP}{3}$$

STATISTICAL ANALYSIS

All the parameters recorded were analyzed using Microsoft excel Software.

Test Applied

- Student's T-Test, Chi - square Test and Pearson's Correlation Test

Significance Criteria

- P Value ≥ 0.05 - Not Significant #
- P Value ≤ 0.05 - Significant *
- P Value ≤ 0.01 - Highly Significant **
- P Value ≤ 0.001 - Very Highly Significant ***

RESULTS

Anthropometric parameters of all subjects: Table 1 shows the mean ± standard error of mean (SEM) of all the anthropometric parameters. The mean ± SEM for age was 20.57 ± 0.91 years, height was 165.86 ± 0.64 cms, weight was 68.46 ± 9.55 kgs and BMI was 21.78 ± 3.32 kg/m^2 respectively.

BMI based comparison of anthropometric parameters of all subjects: In table 2 the mean ± SEM of age and height for Group I, II, III and IV have not shown any significance (p > 0.05). The mean ± SEM of weight and BMI for Group I, II, III and IV was found highly significant (p < 0.05).

BMI based comparison of anthropometric parameters of all male subjects: In table 3 the mean ± SEM of age and height for Group I, II, III and IV was not found significant (p > 0.05). The mean ± SEM of weight and BMI for Group I, II, III M and IV M was found very highly significant (p < 0.05). Overweight group and obese group i.e. III and IV (p < 0.05) was highly significant (p < 0.05, but underweight group II was not found significant (p < 0.05).

BMI based comparison of anthropometric parameters of all female Subjects: In table 4 the mean ± SEM of age and height for Group I, II, III and IV was not found significant (p > 0.05). The mean ± SEM of weight and BMI for Group I, II, III and IV F was found very highly significant (p < 0.05).

Parameters	Mean ± SEM
Age (years)	20.57±0.91
Height (cm)	165.86±0.64
Weight (kg)	68.46±9.55
BMI (Kg/m2)	21.78±3.32

Table-1: Anthropometric parameters of all subjects (n=320)

Cardiovascular parameters of all subjects: Table 5 shows the mean ± SEM for pulse rate was 85.39 ± 1.19 beats/min, SBP was 118.88 ± 1.62 mmHg, DBP was 76.98 ± 1.31 mmHg and MAP was 91.05 ± 1.36 mmHg respectively.

BMI based comparison of cardiovascular parameters of all subjects: In table 6 the mean ± SEM of pulse rate, SBP and DBP for Group I, II, III and IV was found very highly significant (p < 0.05). The mean ± SEM of MAP for Group I, II, III and IV was found significant (p < 0.05).

BMI based comparison of cardiovascular parameters of all male subjects: In table 7 the mean ± SEM of Pulse Rate for Group I, II, III and IV was found very highly significant (p < 0.05). The mean ± SEM of SBP, DBP and MAP for Group I, II, III and IV was found not significant (p > 0.05).

BMI based comparison of cardiovascular parameters of all female subjects: In table 8 the mean ± SEM of Pulse Rate, SBP and DPB for Group I, II, III F and IV was found very highly significant (p < 0.05). The mean ± SEM of MAP for Group I, II, III and IV was found significant (p < 0.05) and highly significant to underweight group (p < 0.05).

Parameters	Group-I (n – 80) Mean ±SEM	Group-II (n- 80) Mean ± SEM	Group-III (n-80) Mean ± SEM	Group-IV (n-80) Mean ± SEM	P value
Age (years)	19.44±0.17	18.97± 0.15	20.83±0.22	23.03±0.22	> 0.05 #
Height (cm)	165.59±1.22	164.25±1.01	165.59±0.97	167.67±1.07	> 0.05 #
Weight (kg)	60.68±1.15	47.14±0.68	74.18±0.95	91.86±1.06	< 0.01 **
BMI (Kg/m²)	21.86±0.19	17.39±0.19 #	27.11±0.09	32.77±0.22	<0.001***

Table-2: BMI based comparison of anthropometric parameters of all subjects (n-320).

Parameters	Group- I M (n – 40) Mean ±SEM	Group- II M (n – 40) mean ± SEM	Group-III M (n – 40) mean ± SEM	Group-IV M (n – 40) mean ± SEM	P value
Age (years)	19.73±0.26	18.93±0.19	21.35±0.34	23.2±0.36	> 0.05 #
Height (cm)	172.64±1.24	169.95±1.19	169.75±1.33	173.08±1.01	> 0.05 #
Weight (kg)	66.35±1.27	51.45±0.71	77.39±1.15	97.43±1.15	< 0.001 ***
BMI (Kg/m²)	21.97±0.26	17.79±0.07 #	26.93±0.2 *	32.62±0.3	<0.001 ***

Table-3: BMI based comparison of anthropometric parameters of all male subjects (n-160)

Parameters	Group- I F (n - 40) Mean ±SEM	Group-II F (n - 40) mean ± SEM	Group-III F (n - 40) mean ± SEM	Group- IV F (n - 40) mean ± SEM	P Value
Age (years)	19.15±0.21	19±0.23	20.33±0.28	22.95±0.31	> 0.05 #
Height (cm)	158.53±1.39	158.55±1.05	161.43±1.07	162.03±1.44	> 0.05 #
Weight (kg)	55.01±1.45	42.83±0.66	70.76±0.96	85.98±1.25	<0.001***
BMI (Kg/m²)	21.75±0.27	16.99±0.13 #	27.21±0.2 *	32.9±0.33	<0.001***

Table-4: BMI based comparison of anthropometric parameters of all female Subjects (n-160)

Parameters	Mean ± SEM
Pulse Rate (beats/min)	85.39 ± 1.19
SBP (mmHg)	118.88 ± 1.62
DBP (mmHg)	76.98 ± 1.31
MAP (mmHg)	91.05 ± 1.36

Table-5: Cardiovascular parameters of all subjects (n-320).

Parameters	Group- I n – 80 Mean ±SEM	Group- II n- 80 Mean ± SEM	Group-III n-80 Mean ± SEM	Group- IV n-80 Mean ± SEM	P value
Pulse Rate (beats/min)	82.54±1.18	86.02±1.47	84.77±1.26	88.24±1.22	<0.001 ***
SBP (mmHg)	118.62±0.94	114.41±1.01	120.86±0.78	121.71±0.61	<0.001***
DBP (mmHg)	77.29±1.01	73.22±0.83	78.07±0.86	79.32±0.6	<0.01**
MAP (mmHg)	91.17±0.89	87.2±0.87	92.37±0.76	93.44±0.58	< 0.05 *

Table-6: BMI based comparison of cardiovascular parameters of all subjects (n-320).

Parameters	Group I M (n-40) Mean ±SEM	Group II M (n-40) Mean ±SEM	Group III M (n-40) Mean ±SEM	Group IV M (n-40) Mean ±SEM	P value
Pulse Rate (beats/min)	81.9±1.55	82±1.76	86.98±1.52	90.2±1.86	<0.001***
SBP (mmHg)	121.55±1.2	118.13±0.63	123.43±1.05	124.13±0.9	> 0.05 #
DBP (mmHg)	79.48±1.27	74.38±0.83	79.7±1.16	81.55±0.74	> 0.05 #
MAP (mmHg)	93.75±1.12	89.45±0.72	94.25±1.05	95.73±0.75	> 0.05 #

Table-7: BMI based comparison of cardio respiratory parameters of all male subjects (n-160).

Parameters	Group-I F (n – 40) Mean ± SEM	Group-II F (n- 40) Mean ± SEM	Group-III F (n-40) Mean ± SEM	Group- IV F (n-40) Mean ± SEM	P value
Pulse Rate (beats/min)	83.18±1.79	90.03±2.19	82.9±1.98	85.7±1.68	<0.001***
SBP (mmHg)	115.68±1.32	110.7±1.87	118.35±1	119.13±0.7	<0.01**
DBP (mmHg)	75.1±1.51	72.05±1.43	76.25±1.25	76.87±0.85	< 0.01**
MAP (mmHg)	88.575±1.28	84.95±1.53 **	90.28±1.06	90.93±0.77	<0.05*

Table-8: BMI based comparison of cardiovascular parameters of all female subjects (n -160).

Parameters	Group A (n – 160 M) Mean±SEM	Group B (n–160 F) Mean±SEM	P value
Pulse Rate (b/m)	85.26±0.87	85.45±0.98	> 0.05 #
SBP (mmHg)	121.80±0.51	115.96±0.69	< 0.001 ***
DBP (mmHg)	78.77±0.55	75.06±0.65	< 0.01 **

Table-9: Comparison of cardiovascular parameters in all male and female (Group A and B) subjects.

Parameters	Correlation coefficient (r)	P- value
BMI vs MAP	0.31	< 0.001***

Table-10: Correlation of BMI with MAP

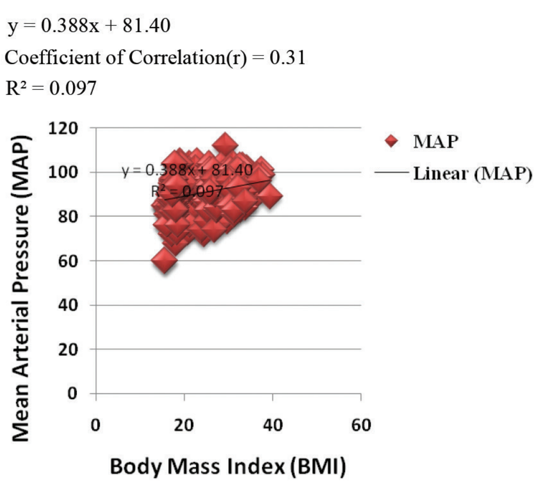

Figure-1: Scatter diagram showing correlation between BMI & MAP.

Comparison of cardiovascular parameters in all male (Group A, n - 160) and female (Group B, n - 160) subjects: In table 9 the mean ± SEM for Pulse Rate of Group **A and B** subjects was found not significant ($p > 0.05$). The mean ± SEM for SBP, DPB and MAP of Group **A** and **B** subjects was found very highly significant ($p < 0.05$).

Correlation of BMI with MAP and PEFR: This table shows the correlation of BMI with MAP and BMI with PEFR. The correlation coefficient between BMI with MAP = 0.31, denotes partial positive correlation. The P-value between BMI & MAP correlation was very highly significant ($p < 0.05$).

DISCUSSION

The increasing number of overweight and obese individuals is a serious health problem worldwide. Growing evidence had clearly and consistently evidenced that obesity is an essential and direct predictor of Cardio vascular function. The main aim of this study was to observe variations in cardiovascular parameters like (Pulse rate, SBP, DBP& MAP) with BMI in different groups (Gr I, Gr II, Gr III, and Gr IV). The data was statistically analyzed by using excel and applying Students

T-Test, Chi-square test and Pearson Correlation Test. The study showed a strong positive correlation among cardio-respiratory parameters with BMI variation. On BMI based comparison the anthropometric parameters like weight & BMI were found statistically very highly significant in total number of subjects ($p <0.05$), whereas age and height was found not significant ($p > 0.05$). Taking into consideration in all study subjects (n-320) the BMI based comparison of cardio-respiratory parameters showed statistically a positive significant association in various groups (Gr I, Gr II, Gr III & Gr IV). The parameters like pulse rate and SBPwas found to be very highly significant ($p < 0.001$) in all subjects (n-320), whereas DBP was found highly significant ($p < 0.01$) and MAP was found significant ($p < 0.05$) in all subjects respectively. In total male subjects (n-160) the BMI based comparison of cardiovascular parameters was significant. The pulse rate was found to be very highly significant ($p < 0.05$) whereas SBP, DBP was found to be highly significant ($p < 0.05$) and MAP was found statistically significant ($p < 0.05$) in all groups of male subject. In total female subjects (n-160). The parameters like SBP and MAP were found very highly significant ($p < 0.001$) whereas DBP was found highly significant ($p < 0.01$) and pulse rate was found not significant ($p > 0.05$) in all groups' female subjects.

The gender based comparison of cardiovascular parameters of Group A and B also showed positive association statistically. The parameters like SBP, MAP were found to be very highly significant statistically ($p < 0.05$) whereas DBP was found highly significant ($p < 0.05$) while pulse rate was found not significant ($p > 0.05$) in comparison of group A with group B. The BMI & gender based comparison of cardiovascular parameters like SBP, MAP between all groups (all male groups and all female groups), and showed very high significant ($p < 0.05$). The pulse rate & DBP between same groups were not significant ($p > 0.05^{\#}$) except obese group that was found to be highly significant ($p < 0.05$) respectively.

Further it was observed that the correlation of BMI with MAP was found to be statistically very highly significant. The correlation coefficient (r) between BMI with MAP was found = 0.31, denotes partial positive correlation. Thus the study showed that on increasing BMI the MAP increases. The results of our study coincide with the results of following studies. Perusse L *et al*. in 2005 study compared several CVD risk factors between four BMI and fitness groups using median split. In agreement with the findings, unfit males and females had higher MAP than their fit counterparts within BMI categories.[12]

Huang *et al*. in 1998 showed the association between change in body weight and incident cases of hypertension and found that weight gain substantially increased the risk of hypertension.[13] The exact underlying pathophysiological mechanisms between change in BMI and blood pressure are still not clear. What is known is that weight gain stimulates sympathetic activation, and also that probably insulin and leptin are involved. Also activation of the rennin – angiotensin system as well as physical compression of kidney may be important factors in linking body weight and elevated blood pressure.[13] This study has helped to make the students aware of their health status in the region of Uttarakhand and it will also benefit them as they have been volunteered to modify their lifestyle.

CONCLUSION

The study demonstrated that BMI is closely associated with MAP. MAP is derived from the combination of standard measures of SBP and DBP. It allows description of BP as a single measurement. Our study concluded that on increasing BMI, the MAP was increased. The weight gain stimulates sympathetic activation, and also that probably insulin and leptin are involved. Also activation of the rennin – angiotensin system as well as physical compression of kidney may be important factors in linking body weight and elevated blood pressure. Therefore, we counseled the subjects regarding the adverse effect of high BMI & maintain their weight by regular exercise and suitable diet pattern to live free of Respiratory disorders.

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