

Research Article

Effect of Age, Gender & BMI on Different Cardiovascular Parameters

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Abstract: The main objective of this study was to assess the effect of Age, Gender and Body Mass Index on different cardiovascular parameters like Systolic Blood pressure, Diastolic Blood pressure and Cardiac Output in Male and Female individuals between the ages of 20-50 years. Developing countries are increasingly faced with the burden of hypertension and other cardiovascular diseases, along with infection and malnutrition. This study was performed on healthy male and female sedentary subjects from middle class with no family and personal history of cardiovascular diseases in the age group of 20-50 years. Male and Female individuals were segregated into three groups based on age as: Group A: 20-30 years; Group B: 30-40 years; Group C: 40-50 years. The results of our study showed a significant increase in BMI, SBP, DBP & CO as the age advances in both Male and Female individuals. Sedentary Males showed a statistically significant increase in SBP, DBP when compared with sedentary females of the same age. BMI showed a significant increase in sedentary males when compared with sedentary females only in Group A. When CO was compared between male and female individuals, a statistically significant increase in CO is seen Sedentary Males in Group C only but not in Group A & group B. Age and BMI have shown a significant impact on SBP, DBP & CO in both the sexes.

Keywords: Body Mass Index (BMI); Cardiac Output (CO); Diastolic Blood Pressure (DBP); Systolic Blood Pressure (SBP).

INTRODUCTION

Excess weight gain is an important risk factor for many medical disorders, including osteoarthritis; sleep apnoea, nonalcoholic fatty liver disease, gall bladder disease, diabetes, cerebrovascular disease, coronary heart disease, kidney disease, and several types of cancer (e.g., breast, colon, kidney, prostate). Cardiovascular disease, occurring through multiple mechanisms like hypertension, diabetes, dyslipidemia, and atherosclerosis is another major consequence of excess weight gain. Population studies have shown that excess weight gain (as estimated by BMI, waist-to-hip ratio, abdominal diameter, and other indices of adiposity) is one of the best predictors for development of hypertension. The relationships between BMI and systolic and diastolic blood pressure appear to be linear in diverse populations [1-4]. The Third National Health and Nutrition Evaluation Survey (NHANES III) showed that men had higher blood pressure than women through middle age [5]. Although the mechanisms responsible for the gender differences in blood pressure control are not clear, there is significant evidence that androgens, such as testosterone, play an important role in gender-associated differences in blood pressure regulation. In women menopause is characterized by increase in blood pressure and the blood pressure does not increase during the transitional phase from perimenopause to menopause [6], but rather the increase in blood pressure after menopause takes an average of 5 to 20 years to develop [5], suggesting that lack of female hormones may not be the only contributing factor for

the elevated blood pressure. Many factors are responsible for the rise of blood pressure, of which age is one of the main responsible factor; because in the process of aging the structural, functional, and biochemical changes occur with the influence of various genetic and environmental factors.

“Intersalt” was a large scale study from men and women from 52 centers and 32 different countries. This study was focused on urinary electrolytes and blood pressure & also provided an opportunity to examine the relation of body weight and blood pressure [7],[8]. The relation of BMI and blood pressure was found to be positive and significant for men and women. The prevalence of hypertension was higher in those individuals who were overweight. They also found lower salt intake, higher potassium intake, and lower alcohol consumption were associated with lower blood pressure for men and women. One limitation of using BMI is that it does not take lean body mass, muscle mass or bone density into consideration when measuring obesity [9].

Arterial BP is determined by cardiac output and total peripheral resistance. Any factor which raises cardiac output or total peripheral resistance will raise BP. Because obese persons are usually associated with the augmented cardiac output (in response to elevated metabolic requirements), at a given level of low or normal BP, obese persons have low total peripheral resistance. Age and hypertension may act independently

to reduce baroreceptor sensitivity [10], [11]. In the Framingham study, for every 4.5 kg of weight gain there was an associated increase in systolic blood pressure of 4 mm Hg in both men and women [12]. The Nurses Health Study reported that hypertension was 2 to 6 times more prevalent among heavier women (BMI of 29 or above) than among less heavy women (BMI less than 22) [13].

Measures of adiposity reported vary from study to study, as do their relationships to Blood Pressure. The most commonly reported adiposity measures include weight, waist circumference, sub scapular and triceps skin fold measures (as well as their sum), and indices such as body mass index (BMI), waist-to hip ratio (WHR), and various skin fold ratios. A recent review of studies that examined the associations of adiposity measures to BP found the vast majority reported significant relationships. Sub scapular skin fold thickness was the best adiposity predictor of BP, but BMI was also found to be a good predictor [14].

Hypertension is directly related with BMI, it shows that with the increase in the BMI the trend of hypertension rises in both females and males. Hypertension is strongly related with age and gender. In males the prevalence of hypertension in general is high in all age groups; however there is a significant rise in the number of hypertensive females in the age group below 30 years in the overweight category and a slight rise in hypertensive trend in females above the age of 59 years in both overweight and obese categories as compare to males. In the normal BMI category, relatively large percentage of males shows sign of hypertension, whereas in the overweight category, hypertension among females is high [15]. Recent evidence indicates that Leptin may represent a link between excess adiposity and increased cardiovascular sympathetic activity. Besides its effect on appetite and metabolism, leptin acts in the hypothalamus to increase blood pressure through activation of the sympathetic nervous system [16]. Low plasma Ghrelin is associated with hypertension [17]. Similarly, plasma adiponectin concentration is significantly lower in men with hypertension than in normotensive men and is negatively correlated with blood pressure in subjects without hypertension [18]. Low Ghrelin and Adiponectin may be independent risk factors for hypertension. The elevated heart rate often found in obesity is mainly due to withdrawal of parasympathetic tone rather than increased sympathetic activity or increased intrinsic heart rate [19],[20]. Three mechanisms play an important role in mediating increased sodium reabsorption, impaired renal pressure natriuresis, and hypertension associated with weight gain. They are increased sympathetic nervous system (SNS) activity; activation of the Renin Angiotensin-Aldosterone system and physical compression of the kidneys by fat accumulation within and around the

kidneys, and by increased abdominal pressure. Excess visceral adipose tissue itself is an important source of cytokines and other factors that create a vascular milieu of inflammation and oxidative stress and that contribute to endothelial dysfunction, vascular stiffening, and eventually atherosclerosis [21].

MATERIALS & METHODS

This study was performed on healthy male and female subjects from middle class with a clean family and personal history of cardiovascular diseases or deaths. Our aim in selecting subjects of middle class is to have the same dietary status.

Exclusion criteria: No H/o smoking or alcoholism, No H/o DM, Hypertension, CV disease. One group A is in the age range of 20-30 years, second group B within the range of 30-40 years and another group C of 40-50 years. These subjects of the three groups are categorized as sedentary with routine life activities and without any sort of physical exercise like male and female students, house wives, shop keepers. The age of each individual is recorded in completed years. The height and weight were recorded for each subject in meters and kilograms respectively. Body mass index was obtained as weight in kilograms / height in meters².

Heart rate was recorded by counting the pulse rate by palpation of the radial artery. The haemoglobin was measured by acid-hematin method with the use of Sahli's haemoglobinometer. Then volunteer is made to lie flat on the table near the echo-cardiogram for the recording of the blood pressure, after which on the same table cardiac echo was also done.

The systolic and diastolic pressures were recorded with the use of mercury sphygmomanometer and the stethoscope, by both palpatory and auscultatory methods. Statistical analysis was done using Graph pad prism 6 software.

Un- paired t test was used to compare the mean \pm SD.

This study was approved by the Institutional Ethical Committee of Dr.PSIMS & RF.

RESULTS

The mean BMI in Sedentary Males in Group A, Group B and Group C was 25.80 ± 0.4368 kg/m², 27.42 ± 0.4389 kg/m² and 29.30 ± 0.3333 kg/m² respectively. Statistically significant increase in BMI was seen when we compare Group A & Group B (p value = 0.0116); Group B & Group C (p value = 0.0013). Similarly the mean BMI in Sedentary Females in Group A, Group B and Group C was 21.86 ± 0.4846 kg/m², 26.40 ± 0.4615 kg/m² and 28.38 ± 0.4483 kg/m² respectively. Statistically significant increase in BMI was seen when we compare Group A & Group B (p

value < 0.0001) ;Group B & Group C (p value = 0.0035).

RESULTS:

TABLE:- 1. Comparison of different CV parameters in Males between Group A & Group B; Group B & Group C (SM-SEDENTARY MALE)

	SM Group A MEAN±SD	SM Group B MEAN±SD	P-VALUE	SM Group B MEAN±SD	SM Group C MEAN±SD	P-VALUE
BMI Kg/m ²	25.80 ± 0.4368	27.42 ± 0.4389	0.0116 *	27.42 ± 0.4389	29.30 ± 0.3333	0.0013 **
SBP mmHg	122.4 ± 0.7574	128.0 ± 0.4761	< 0.0001****	128.0 ± 0.4761	135.5 ± 0.4800	<0 .0001****
DBP mmHg	80.00 ± 0.5416	84.40 ± 0.4472	< 0.0001****	84.40 ± 0.4472	87.52 ± 0.4208	< 0 .0001****
CO ml/min	4498 ± 23.19	4615 ± 35.89	0.0086 **	4615 ± 35.89	4985 ± 50.81	< 0 .0001****

TABLE: 2 Comparison of different CV parameters in Females between Group A & Group B; Group B & Group C (SF-SEDENTARY FEMALE)

	SF Group A MEAN±SD	SF Group B MEAN±SD	P-VALUE	SF Group B MEAN±SD	SF Group C MEAN±SD	P-VALUE
BMI Kg/m ²	21.86 ± 0.4846	26.40 ± 0.4615	< 0.0001****	26.40 ± 0.4615	28.38 ± 0.4483	0.0035 **
SBP mmHg	120.2 ± 0.7445	122.6 ± 0.4969	0.0126 *	122.6 ± 0.4969	127.0 ± 0.5552	< 0.0001****
DBP mmHg	77.36 ± 0.5192	84.40 ± 0.4472	< 0.0001****	81.08 ± 0.5444	85.04 ± 0.4183	< 0.0001****
CO ml/min	4454 ± 27.72	4654 ± 35.25	< 0.0001****	4654 ± 35.25	4798 ± 56.09	0.0348 *

TABLE: 3 Comparison of different CV parameters in Males and Females between Group A & Group C

	SM Group A MEAN±SD	SM Group C MEAN±SD	P-VALUE	SF Group A MEAN±SD	SF Group C MEAN±SD	P-VALUE
BMI(kg/m ²)	25.80 ± 0.4368	29.30 ± 0.3333	< 0.0001****	21.86 ± 0.4846	28.38 ± 0.4483	< 0.0001****
SBP(mmHg)	122.4 ± 0.7574	135.5 ± 0.4800	< 0.0001****	120.2 ± 0.7445	127.0 ± 0.5552	< 0.0001****
DBP(mmHg)	80.00 ± 0.5416	87.52 ± 0.4208	< 0.0001****	77.36 ± 0.5192	85.04 ± 0.4183	< 0.0001****
CO(ml/min)	4498 ± 23.19	4985 ± 50.81	< 0.0001****	4454 ± 27.72	4798 ± 56.09	< 0.0001****

Table: 4 Comparison of different CV parameters in Males & Females in Group A & in Group B

	SM Group A MEAN±SD	SF group A MEAN±SD	P-VALUE	SM Group B MEAN±SD	SF Group B MEAN±SD	P-VALUE
BMI(kg/m ²)	25.80 ± 0.4368	21.86 ± 0.4846	< 0.0001 ****	27.42 ± 0.4389	26.40 ± 0.4615	0.1153 NS
SBP(mmHg)	122.4 ± 0.7574	120.2 ± 0.7445	0.0437 *	128.0 ± 0.4761	122.6 ± 0.4969	< 0.0001****
DBP(mmHg)	80.00 ± 0.5416	77.36 ± 0.5192	0.0010***	84.40 ± 0.4472	81.08 ± 0.5444	< 0.0001****
CO(ml/min)	4498 ± 23.19	4454 ± 27.72	0.2244 NS	4615 ± 35.89	4654 ± 35.25	0.4476 NS

Table: 5 Comparison of different CV parameters in Males & Females in Group C

	SM Group C MEAN±SD	SF Group C MEAN±SD	P-VALUE
BMI(kg/m ²)	29.30 ± 0.3333	28.38 ± 0.4483	0.1044 NS
SBP(mmHg)	135.5 ± 0.4800	127.0 ± 0.5552	< 0.0001****
DBP(mmHg)	87.52 ± 0.4208	85.04 ± 0.4183	0.0001***
CO(ml/min)	4985 ± 50.81	4798 ± 56.09	0.0168 *

The mean SBP in Sedentary Males in Group A , Group B and Group C was 122.4 ± 0.7574 mmHg, 128.0 ± 0.4761 mmHg and 135.5 ± 0.4800 mmHg respectively. Statistically significant increase in SBP was seen when we compare Group A & Group B (p value < 0.0001); Group B & Group C (p value < 0.0001). Similarly the mean SBP in Sedentary Females in Group A , Group B and Group C was 120.2 ± 0.7445 mmHg , 122.6 ± 0.4969 mmHg and 127.0 ± 0.5552 mmHg respectively. Statistically significant increase in SBP was seen when we compare Group A & Group B (p value = 0.0126); Group B & Group C (p value < 0.0001).

The mean DBP in Sedentary Males in Group A , Group B and Group C was 80.00 ± 0.5416 mmHg, 84.40 ± 0.4472 mmHg and 87.52 ± 0.4208 mmHg respectively. Statistically significant increase in DBP was seen when we compare Group A & Group B (p value < 0.0001); Group B & Group C (p value < 0.0001). Similarly the mean DBP in Sedentary Females in Group A , Group B and Group C was 77.36 ± 0.5192 mmHg , 84.40 ± 0.4472 mmHg and 85.04 ± 0.4183 mmHg respectively. Statistically significant increase in DBP was seen when we compare Group A & Group B (p value < 0.0001) ; Group B & Group C (p value < 0.0001).

The mean CO in Sedentary Males in Group A, Group B and Group C was 4498 ± 23.19 ml/min, 4615 ± 35.89 ml/min and 4985 ± 50.81ml/min respectively. Statistically significant increase in CO was seen when we compare Group A & Group B (p value = 0.0086); Group B & Group C (p value < 0.0001). Similarly the mean CO in Sedentary Females in Group A, Group B and Group C was 4454 ± 27.72 ml/min, 4654 ± 35.25 ml/min and 4798 ± 56.09ml/min respectively. Statistically significant increase in CO was seen when we compare Group A & Group B (p value < 0.0001); Group B & Group C (p value = 0.0348).

When we study the Sex variation between the different cardiovascular parameters, Sedentary Male in Group A showed a statistically significant increase in BMI (p value < 0.0001); SBP (p = 0.0437); DBP (p = 0.0010) when compared with Sedentary Female in the same Group. The mean CO (p = 0.2244 NS) did not

show any significant change when compared between Sedentary Male & Female in Group A.

When we study the Sex variation between the different cardiovascular parameters, Sedentary Male in Group B showed a statistically significant increase in SBP (p < 0.0001) ; DBP (p < 0.0001) when compared with Sedentary Female in the same Group. The mean BMI (p value = 0.1153 NS) & mean CO (p = 0.4476 NS) did not show any significant change when compared between Sedentary Male & Female in Group B.

When we study the Sex variation between the different cardiovascular parameters, Sedentary Male in Group C showed a statistically significant increase in SBP (p < 0.0001) ; DBP (p < 0.0001) & mean CO (p = 0.0168) when compared with Sedentary Female in the same Group. The mean BMI did not show any significant change when compared between Sedentary Male & Female in Group B & Group C (p = 0.1153, p value = 0.1044 NS respectively).

DISCUSSION:

The results of our study showed a significant increase in BMI, SBP, DBP & CO as the age advances in both the genders. Wiinber et al [22] studied 352 normotensive (for age) Danish men and women, aged 20 to 79 years, and found that blood pressure increased with aging in both men and women, but that men had higher 24-hour mean blood pressure, by approximately 6 to 10 mm Hg, than did women, until the age of 70 to 79 years, when blood pressure was similar for men and women. Khoury et al [23] performed ambulatory blood pressure monitoring on 131 men and women, aged 50 to 60 years, and found that men had higher blood pressure than did women. The results of our study were in accordance with the above studies. Seidell et al [24] concluded from a multicenter study of women that among anthropometric (AP) variables, BMI was the best overall predictor of both SBP and DBP . The significant positive association between BMI and both SBP and DBP has been reported in studies of African-Americans [25], Chinese [26] , [27] , Africans, and Caribbeans [28]. The significant association between BMI and SBP, DBP observed in our study correlates with these studies.

Gregory Livshits et al [29] studied about the familial factors of blood pressure and adiposity co variation and observed that SBP , DBP each showed significant phenotypic correlations with BMI and anthropometric factors with a substantial genetic component . Mane SV et al [30] conducted studies to assess the risk factors for lifestyle diseases among adolescents in Western India and concluded that increasing BMI contributed to an increase in systolic BP and diastolic BP. Stress appeared to be significantly correlated to BMI and systolic BP.

Systolic blood pressure, pulse pressure, Age, height, diastolic blood pressure, fasting blood sugar and hemoglobin had a positive correlation with left ventricular mass but the correlation was not significant [31] . Ghosh et al [32] demonstrated that in Bengalese Hindu men from West Bengal with average age of 37.5 years, obesity measures in the form of Waist Stature Ratio (WSR) and BMI explained that the greater risk of developing hypertension was associated with increasing BMI. Siji Mathew et al [33] observed that both age and gender are important atherogenic factors, which indicate that with increase in age, the older individuals both male and female are more susceptible to the development of Hypertension and Cardiovascular Diseases. After adjusted for age, sex, cigarette smoking, alcohol consumption, high school education, physical inactivity, geographic region, and urbanization, Hongwei Wang et al [34] observed that the effects of systolic or diastolic BP on risk of CVD generally increased with the increasing BMI levels. Average systolic and diastolic blood pressures in men less than 60 years of age are higher than in age-matched women by 6–7mmHg and 3–5 mmHg, respectively [35-37]. After that time, blood pressure (particularly systolic blood pressure) increases in women so that hypertension becomes more prevalent [36] or atleast as prevalent in women as men.

CONCLUSION

This study demonstrated that Age, BMI were closely associated with BP. The risk of hypertension is higher among population groups with overweight and obesity. The relationship between BMI and BP in this study might be confounded by dietary salt intake and also physical activity levels, which are difficult to standardize. Limitations of this study: Dietary habits were not taken into consideration and also the study was a cross sectional study. Life style modification and preventive approaches were needed for the management of elevated BP in developing countries.

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