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ORIGINAL PAPER

Ajay Soni [1(ABCG)], Nazeem Ishrat Siddiqui [2(CDEFG)], Ravindra Wadhwani [3(ACF)]

Relative influence of body mass index and socioeconomic class on blood pressure levels and health

[1] Department of Physiology, MGM Medical College, Indore, India
[2] Professor & Head, Department of Physiology, Government Medical College, Khandwa, India
[3] Professor & Head, Department of Physiology, MGM Medical College, Indore, India

ABSTRACT

Introduction. Blood pressure (BP) is a complex entity which is influenced by many factors. The impact of socioeconomic class and body mass index (BMI) on hypertension has been reported in the past but literature on their influence on blood pressure in healthy adolescents is very limited.

Aim. The aim of the study is to assess the influence of BMI and socioeconomic status on BP in healthy adolescents.

Material and methods. This cross sectional study includes three hundred healthy adolescents.

Anthropometric and BP measurements were done. BMI categories were derived using WHO Asia Pacific guidelines. An updated Kuppuswami scale was used for determining socioeconomic status.

Multiple regression analysis and analysis of variance was used to study impact of socioeconomic and BMI classes on BP.

Results. Obese subjects of upper socioeconomic class have higher blood pressure values. Strong significant differences in the mean values of systolic blood pressure (f-23.569; p<0.00001), diastolic blood pressure (f-22.470; p<0.00001) and mean arterial pressure (f-27.454; <0.00001) were observed in different BMI classes. Except for diastolic blood pressure (f-2.713; p <0.030) rest of BP indices did not differ significantly in different SES classes.

Conclusion. Obese subjects of upper socioeconomic class are prone for development of future hypertension. High BMI is significant risk factor for high BP, however socioeconomic class of the subject should also be considered as predisposing factor for high BP.

Keywords. blood pressure, BMI, obesity, socioeconomic class

Introduction

Economic transition in developing countries has resulted in changes in lifestyle and socioeconomic class of individuals.[1] Consequently the prevalence of overweight/obesity and hypertension is on rise and has reached to epidemic proportions.[1-3] It has replaced the more traditional causes of ill-health such as under nutrition and infectious diseases.[1,3,4] According to World Health Organization, cardiovascular diseases will be the largest cause of death and disability in India by 2020.[1,5,6]

Corresponding author: Nazeem Ishrat Siddiqui, email: drnazeemishrat@yahoo.com

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BP is a complex entity which is influenced by many factors.[7] BMI and socioeconomic status (SES) are important determining factors for BP levels.[7,8] BMI has been extensively studied in the past epidemiological studies and was found to be positively associated with BP levels. Mean values of systolic blood pressure (SBP) and diastolic blood pressure (DBP) were reported higher in subjects with higher BMI.[9-11]

SES is an important psychosocial variable which has been observed to be associated with increased risk of stroke and hypertension.[15,16] The impact of change in SES on cardiovascular diseases and hypertension has been reported in the past studies however, literature on influence of SES and BP levels in normal healthy adults is still very limited.[2,12-14]

Aim

The purpose of this study is to ascertain influence of SES and BMI on blood pressure levels of a healthy adolescent population. This will help to reduce the future burden of cardiovascular disorders, resulting from change in socioeconomic class and obesity of the individual.

Material and methods

In this cross sectional study, three hundred (300) healthy adolescents with a mean age of 18.82 years (ranging from 18 to 25 years) were enrolled. After the subjects were instructed about the aims of the study, anthropometric measurements and BP recording were done as per the standard protocol.[17,18]

Weight was measured in standing position in light clothing without shoes to the nearest 0.1kg on a calibrated mechanical weighing scale (Krups India). Wall mounted stadiometer was used to measure height in erect posture to the nearest 0.1 cm. BMI was derived using standard formula BMI= Weight (kg)/ Height (m^2). Participants were classified into underweight (BMI < 18.5), normal weight (BMI from 18.5 to 24.9), over weight (BMI from 25 to 29.9) and obese (BMI >30) groups using WHO Asia Pacific guidelines.[19]

BP was recorded with a standardized mercury sphygmomanometer after five minutes of rest in a seated position with appropriate size of cuff applied to the right upper arm. Korotkoff phase-I was recorded as SBP and Korotkoff phase-V as DBP. Mean of last two readings with a time interval of one minute were used as final readings. Pulse Pressure (PP) was calculated by subtracting DBP from SBP. Mean Arterial Pressure (MAP) was calculated using the formula MAP = DBP+1/3 (PP). All the recordings were done at a fixed time (after 10:30 AM) by the investigator of the project without wearing white coat. For determination of socioeconomic class updated Kuppuswami scale was used.[20] Informed written consent and ethical clearance was sought prior to study.

Statistical analysis

Continuous variables were expressed as Mean and SD whereas categorical variables are expressed as number and percentages. Multiple regression analysis was used to find out significant predictors of BP. ANOVA and Tukey HSD post-hoc analysis was used to compare mean. The level of significance is fixed at $p < 0.05$. All the calculations were done on Med Calc (version 18.2.1) statistical software.

Results

The baseline characteristics of the study population are shown in the Table 1.

Table 1. Characteristics of study population

Parameter	Mean ± SD	95% CI
Weight (kg)	61.10 ±13.72	58.88 to 63.31
Height (cm)	166.0 ± 9.32	165.16 to 168.17
BMI (kg/m^2)	21.96 ± 4.28	21.27 to 21.27
SBP (mmHg)	123.0 ± 14.155	120.71 to125.28
DBP (mmHg)	74.70 ± 7.33	73.52 to75.88
MAP (mmHg)	89.709 ±8.91	88.696 to 90.721

On multiple regression analysis blood pressure indices (SBP, DBP and MAP) were significantly predicted by BMI, however socioeconomic class did not predicted blood pressure significantly (Table 2).

Mean values of SBP (135.75 ± 9.37 mmHg), DBP (80.62 ± 7.40mmHg) and MAP (99.00 ± 7.49 mmHg) were higher in obese group. Strong significant differences in the mean values of SBP ($f=23.569$; $p<0.00001$), DBP ($f=22.470$; $p<0.00001$) and MAP ($f=27.454$; <0.0000!) were observed in different BMI classes (Table 3). On Tukey HSD post–hoc test, highly significant intergroup differences were noted in different BMI classes except between overweight and obese class (Table 4).

As depicted in the Table 5, highest mean values of SBP, DBP and MAP were found in upper socioeconomic class (124.48 ± 18.67, 75.66±7.61 & 91.93 ± 10.74 respectively for SBP, DBP and MAP). On analysis of variance, except for DBP ($f=2.713$; $p= 0.030$) rest of BP indices did not differ significantly in different SES classes ($f=1.254$; $p = 0.288$ and $f=2.252$; $p=0.063$ respectively for SBP and MAP).

Prevalence of obesity and high blood pressure in the present study is 5.33% and 8.66% respectively. Highest number of subjects with elevated BP was found in upper socioeconomic class and overweight/obese category (Figure 1).

Table 2. Multiple regression analysis for prediction of BP indices

	Independent variables	Coefficient	Std. Error	$r_{partial}$	t	P
SBP (mmHg)	(Constant)	119.7405				
	BMI Class	4.0475	1.3615	0.1888	2.973	0.0033
	SES Class	-1.4590	0.9781	-0.09604	-1.492	0.1371
DBP (mmHg)	(Constant)	73.9170				
	BMI Class	1.8016	0.7268	0.1583	2.479	0.0139
	SES Class	-0.9762	0.5222	-0.1201	-1.869	0.0628
MAP (mmHg)	(Constant)	89.1907				
	BMI Class	2.5504	0.8636	0.1876	2.953	0.0035
	SES Class	-1.1370	0.6204	-0.1177	-1.833	0.0681

Table 3. Effect of BMI category on BP

	Under weight	Normal weight	Overweight	Obese	f- value	p-value
SBP (mmHg)	116.19±9.00	121.87±12.07	132.52±19.06	135.75±9.37	23.569	**<0.00001**
DBP (mmHg)	69.86±6.41	74.09±7.34	78.93±7.01	80.62±7.40	22.470	**<0.00001**
MAP (mmHg)	85.30±6.70	90.02±8.11	96.79±10.32	99.00±7.49	27.454	**<0.00001**

Table 4. Tukey HSD post-hoc test analysis of BP within BMI classes

BMI Class	SBP			DBP			MAP		
	Diff	95%CI	p	Diff	95%CI	p	Diff	95%CI	p
Under weight v/s Normal weight	5.6	1.43 to 9.92	**<0.001**	4.2	1.83 to 6.62	**0.003**	4.7	1.97 to 7.46	**<0.001**
Under weight v/s Over weight	16.3	5.76 to 12.37	**<0.001**	9.0	5.76to 12.37	**<0.0001**	11.4	7.70 to 15.2	**<0.001**
Normal weight v/s Obese	19.5	10.79 to 28.3	**<0.001**	10.7	5.82 to 15.69	**<0.0001**	13.7	8.03to 19.36	**<0.001**
Normal weight v/s Over weight	10.6	5.26 to 16.03	**<0.001**	4.8	1.80 to 7.87	**<0.0001**	6.7	3.28to 10.25	**<0.001**
Normal weight v/s Obese	13.8	5.43 to 22.32	**<0.001**	6.5	1.76 to 11.29	**<0.0001**	8.9	3.51 to 14.4	**<0.001**
Over weight v/s Obese	3.2	-6.13 to 12.59	0.80	1.6	-3.58 to 6.96	0.809	2.2	-3.84 to 8.2	0.78

Table 5. Effect of Socio-economic Class (SES) on Blood Pressure

B.P Indices	Upper Class	Upper middle	Lower Middle	Upper Lower	Lower	f- Value	p-value
SBP (mmHg)	124.48±18.67	122.01±11.75	120.00±11.5	119.64±10.9	119.5±8.38	1.25	0.288
DBP (mmHg)	75.66 ±7.61	73.80 ±7.29	72.24 ±8.39	72.07 ±7.22	68.5 ±4.12	2.71	0.030
MAP (mmHg)	91.93 ±10.74	89.87 ±7.94	88.16 ±8.87	87.92 ±7.81	85.50 ±5.1	2.25	0.063

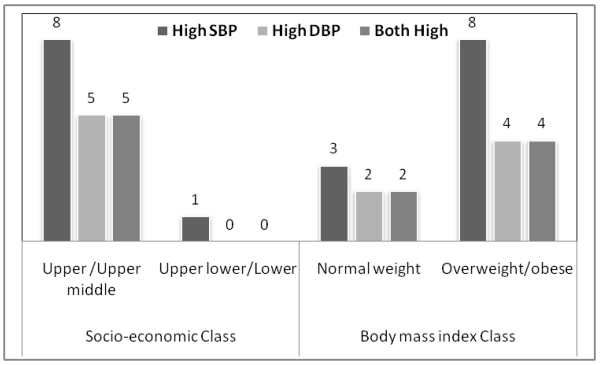

Fig. 1. Prevalence high BP within socio-economic and BMI classes

Discussion

There is paucity of data from developing countries on the prevalence of obesity and high blood pressure. Most of the reported data is from the developed countries which suggest higher prevalence of obesity and hypertension.[1-3]

The situation in the developing nations is changing rapidly due to rapid economic transitions. It has improved the socioeconomic status, reduces the physical activity and thus increases proneness for obesity and high BP.[3-5] It is because of this the prevalence of hypertension and obesity in the developing nations has reached epidemic proportions.[7-11]

In the present study SBP, DBP and MAP were significantly predicted by BMI. Mean values of SBP, DBP and MAP were significantly higher ($p<0.0001$) and differed across BMI categories . Subjects with elevated blood pressure (BP) levels were greater (25.08%) in over weight and obese group, indicating strong influence of BMI on BP. These findings are in agreement with previous studies which support that BMI is not merely a marker of obesity but it is causally associated with BP.[21-24] Obesity-associated rise in BP is a consequence of inadequate vasodilatation in presence of increased blood volume and cardiac output, which are natural consequences of an increase body mass.[25,26]

The impact of socioeconomic class (SES) on BP was studied in several epidemiologic studies with conflicting results.[4,11-14] In one of the past study high BP levels were observed in lower SES.[11] In another study negative correlation between SES and blood pressure (BP) was observed in normotensive subjects.[12] However, no association between SES and BP was observed in one of the previous study.[13] These variations might be due to differences in the populations and methodologies used to study this question. Most of the negative studies with regard to SES and BP were originated in underdeveloped countries suggesting that SES parameters influence BP differently in developed and developing societies.[27] In the present study mean SBP & DBP values were higher in upper SES. On statistical analysis only DBP has showed significant difference amongst the social classes. This is in agreement to the findings of past study.[4]

The mechanisms through which SES affect blood pressure are still unknown.[27] However It is suggested that the unfavorable metabolic and neuro-hormonal profile which is associated with a particular SES may contribute to the elevation of BP.[28] Furthermore, the relative impact of SES on BP is weak as compared to BMI.[27]

Total prevalence of obesity in the study was 5.33%, this is in agreement to the reported prevalence rates of obesity for India.[29] Highest numbers of subjects (8.66%) with elevated BP were found in over weight /obese and upper SES class respectively.

With the continued economic growth of the nation the percentage of people in the high socioeconomic group will increase further, this may lead to a higher prevalence of hypertension and cardiovascular disorders. Reduction in body weight early during the adolescent period particularly in high SES will be an important preventive measure to control this trend.[4]

Limitations

Small sample of a particular population group, single measurement of BP are the main limitations. Furthermore, causal relationships cannot be drawn because of cross-sectional nature of our study.

Conclusion

In the present study high BP were observed in overweight/obese and subjects in upper socioeconomic class, indicating their proneness for future hypertension. Therefore along with BMI, socioeconomic class of the subject should also be considered as a risk factor for high blood pressure.

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