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Association of Anthropometric Parameters with Blood Pressure in Urban Adult Females of Andhra Pradesh

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ABSTRACT An attempt has been made in the present cross-sectional study to know the association between overweight/obesity and hypertension in an adult female population from Tirupati town of Andhra Pradesh, India. Data on body mass index, waist and hip circumference, waist hip ratio, blood pressure, other demographic and life style measures were collected from 772 adult healthy females. The percentage prevalences were hypertension: 5.41%; obesity: 1.4% and WHR: 66.29%. Mean systolic blood pressure (SBP) and diastolic blood pressure (DBP) did not show significant variation across the BMI quintiles, however BMI>25.0 kg/m^2 evinced with an increased blood pressure. A significant increase in mean SBP (0.381, $p < 0.05$) and DBP (0.343, $p < 0.05$) are noticed with advancement of age. The odds of hypertension are : >60 yrs (0.12, 95%CI; 0.06, 0.26), overweigh (1.34, 95% CI, 0.29, 6.13), obesity (4.37, 95%CI: 0.86, 22.18), higher socio-economic status (1.24, 95% CI: 0.61, 2.53), mild physical activity (17.10, 95%CI: 6.97, 41.97. In conclusion, it is attributed that body mass index is associated with hypertension under the changing socio-economic and life style transition.

INTRODUCTION

Overweight is defined as a body weight that exceeds the acceptable weight for a particular person, based on the individual's age, height and/or frame size (Kuczmarski et al. 2000). It is also defined as a body mass index (BMI) of 25-29.9 kg/m^2; whereas, obesity is defined as a BMI greater than or equal to 30 kg/m^2 (WHO 1998). Problems of overweight and obesity are caused by chronic imbalance between energy intake and actual energy needs of the body.

Overweight and obesity pose a major risk for chronic diseases, which include hypertension, type 2 diabetes, cardiovascular diseases, stroke, musculoskeletal disorders and certain forms of cancer (Tesfaye et al. 2007). Globally, there are more than one billion overweight adults; at least 300 million of them are obese. High blood pressure (BP) is estimated to cause 7.1 million deaths, about 13% of the total. About 62% of cerebrovascular diseases and 49% of ischemic heart diseases are attributable to suboptimal BP (systolic >115mm Hg). The relevance of both hypertension and obesity, as important public health challenges, is increasing worldwide. Compared with the year 2000, the number of adults with hypertension is predicted to increase by 60% to a total of 1.56 billion by the year 2025 (Kearney et al. 2005). Frequent exposure to energy dense foods and leisure time physical activity, the number of overweight and obese individual's increases to epidemic proportions (WHO 2002).

Prospective studies have emphasized that blood pressure levels and the prevalence of hypertension are related to overall and abdominal adiposity (Kotchen et al. 2008). The degree of association with indicators of adiposity varies between the populations. For example, Sung et al. (2007) in their study identified the importance of waist circumference as a significant variable in assessing the prevalence of hypertension. Similar observations were noticed with different body mass indicators elsewhere (Reddy et al. 2010). Population studies have clearly identified the role of obesity in developing hypertension, but the degree of association and the mechanism is yet to be elucidated as both the obesity and hypertension of life style mediated conditions.

Obesity and hypertension have been shown to increase in parallel across populations along with their degree of development and acculturation (Kaufman et al. 1996; Cooper et al. 1997). Developing countries have a higher susceptibility of blood pressure (BP) to excessive adiposity than Western populations and will be more severely affected, particularly in terms of

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hypertension driven cardiovascular morbidity and mortality, by the current global upward trend in obesity (Cooper and Rotimi 1997; Zhou et al. 2008). This assumption has to be tested against the background of existing knowledge about the obesity effect of hypertension. In the light of this background, the present study undertaken to unravel the importance of a battery of anthropometric markers and life style variables in assessing variation in blood pressure levels and the prevalence of hypertension among the adult females of Andhra Pradesh.

MATERIAL AND METHODS

The present study was conducted among the adult females in the age range of 20 to 70 years in Tirupati town of Chittoor district, Andhra Pradesh. The sampling method and the survey instrument have been validated in earlier studies (Reddy et al. 2010). Subject's enrolment was based on electoral list of Tirupati Town. A simple random sampling technique was followed in the selection of subjects. A total of 772 females were accepted to participate in the study. The study was approved by the Sri Venkateswara University institutional ethics committee. Pregnancy, usage of antihypertensive medication and any gross physical abnormalities were the exclusion criteria against the subject enrolment. The present study focusing on body mass index and blood pressure has a cross sectional descriptive nature, allowing internal comparisons between the major socio-demographic groups such as sex, education, occupation etc. Socio-economic status was assessed as per Singh et al. (1997) (In India, socio-economic status is divided into five grades. Grade 1 is highest class and Grade V is lowest class).

Data were collected using a pretested questionnaire and the physical measurements like weight, height, circumferences of waist and hip and blood pressure were collected from each individual as specified by Weiner and Lourie (1981). Body mass index (BMI) was calculated as weight in kg/height in metre^2 (kg/m^2) and obesity was defined as BMI>30 kgm^{-2}. Abdominal adiposity was defined as WHR >0.85 (WHO 1995).

Blood pressure was measured with a random zero mudler sphygmomanometer at the study site in a sitting position after the participant rested for at least 5 min. Three consecutive measurements were taken with an interval of 3 min in between. Hypertension was diagnosed when the systolic blood pressure was > 140 mmHg or the diastolic blood pressure was > 90 mmHg, as per the guidelines prescribed by the Joint National Committee on detection, evaluation and treatment of high blood pressure (Chobanian et al. 2003).

Statistical analysis was carried out via SPSS – 16.0 and the alpha levels were set at $p < 0.05$. Continuous variables were reported as mean± SD. One way analysis of variance was applied to see the changes in blood pressure according to the categories of age groups and BMI quartiles. Correlations between continuous variables were examined by using correlation coefficients. Further, logistic regression analysis was carried out to determine the odds of hypertension across the age groups, BMI and WHR categories, education and occupation, while controlling for possible confounding.

RESULTS

A total of 772 females in the age range of 20-70 years participated in the study. Demographics and percentage prevalence of the risk factors are presented in Table 1. The subjects were divided into 20 years age class intervals and the sample size in each age group was shown. About 66% of the present sample belongs to SES-4 group and 34% are SES-3 group. 37.56% of the females involved in heavy physical activity, about 51.55% in moderate activity and only 10.88% in mild activity. As per the BMI classification 46.11% of the present sample is underweight, and 47.93% are normal weight, 4.4% are overweight and 1.15% is obese. 69.17% are reported with WHR. Hypertension is recorded to an extent of 4.66 %.

Table 2 shows the mean levels of body mass index, waist hip ratio and blood pressure levels for women. Significant positive rank correlations were found between SES levels and weight and body mass index. On the other hand, in women, significant negative rank correlation was observed only for hip circumference. In women significant correlations were observed between age and waist (r=0.25), WHR (r=0.187), systolic BP (r= 0.381) and diastolic BP (r=0.343); BMI and waist (r= 0.668); diastolic BP (0.05); waist and WHR (r= 0.37), systolic BP (r= 0.108), diastolic BP (r= 0.157); WHR and systolic BP (r= 0.124); diastolic BP

Table 1: Description of the demographics and risk factor prevelence

Variable	*N =772*
Age (in years)	
20-39	450 (58.29)
40-59	242 (31.35)
>60	80 (10.36)
Socio-economic Status (SES)	
SES-3	262 (33.93)
SES-4	510 (66.06)
Physical Activity	
Mild	84 (10.88)
Moderate	398 (51.55)
Heavy	290 (37.56)
BMI Categories	
Underweight	356 (46.11)
Normal	370 (47.93)
Overweight	34 (4.40)
Obese	12 (1.15)
WHR (Waist Hip Ratio Women > 0.85)	534 (69.17)
Hypertensive	36 (4.66)

( ) = percentage

Table 2: Descriptive statistics for the anthropometry and blood pressure in the study population

Variable	*Female*		
	Mean ± SD	*SES*	*PA*
Height (132-165 cm)	149.31 ± 6.17	0.11	0.07
Weight (32-64 Kg)	42.60 ± 5.89	0.10*	-0.03
Body mass index (15.06-26.64)	19.10 ± 2.33	0.13*	-0.09
Waist circumference (50-86 cm)	66.22 ± 5.49	0.03	-0.71
Hip circumference (59-97 cm)	76.42 ± 6.25	0.01	-0.15*
WHR (0.72-1.00)	0.87 ± 0.05	0.04	-0.06
Systolic BP (100-165 mmHg)	123.69 ± 11.15	-0.04	-0.09
Diastolic BP (60-110 mmHg)	79.27 ± 7.21	-0.02	-0.04

*p<0.05; ( ) = range; SES= socio-economic status; PA= physical activity

(r= 0.137); systolic BP and diastolic BP (r= 0.711) respectively (Table 3).

There is no significant increase in the prevalence of hypertensive's and WHR across the BMI categories (Table 4). On the other hand, a significant increase in overweight/obesity and WHR is noticed among the females across the categories of waist circumference (Table 5). While waist hip ratios were taken into consideration, both hypertension and WHR failed to show significant association across the categories of WHR (Table 6).

Selected socio-demographic and anthropometric characteristics that are considered as possible determinants of hypertension were subjected to a logistic regression analyses and the

Table 3: Correlation coefficients for obesity indices with blood pressure

Females	*Age*	*BMI*	*Waist*	*WHR*	*Systolic BP*	*Diastolic BP*
Age	-	0.077	0.250*	0.187*	0.381*	0.343*
BMI		-	0.668*	0.084	0.094	0.046*
Waist			-	0.370*	0.108*	0.157*
WHR				-	0.124*	0.137*
Systolic BP					-	0.711*
Diastolic BP						-

*p<0.05

Table 4: Prevalence of risk factors by body mass index

Risk factor/BMI	*< 17.99*	*18.00-19.99*	*20.00-22.99*	*23.00-24.99*	*>25.00*	r^2
Number	288	226	212	34	12	
WHR	180(62.50)	146(64.60)	174(82.07)	24(70.59)	10(83.33)	0.03
Hypertension	14 (1.68)	8 (3.53)	10 (4.72)	2 (5.88)	2(16.66)	0.01

*BMI= body mass index

Table 5: Prevalence of risk factors by waist circumference

Risk factor/WC	*50-59*	*60-69*	*70-79*	*80-89*	r^2
Number	64	520	172	16	
Overweight/obesity	0 (0.00)	6 (1.15)	26(15.11)	14(87.50)	0.35*
WHR	14(21.88)	354(68.08)	152(88.37)	14(87.50)	0.13*
Hypertension	0 (0.00)	22 (4.23)	12 (6.97)	2(12.5)	0.01

*WC= waist cirumference

Table 6: Prevalence of risk factors by waist hip ratio

Risk factor/WHR	*<0.74*	*0.75-0.79*	*0.80-0.84*	*0.85-0.89*	*0.90-0.94*	*>0.95*	r^2
Number	10	58	170	300	174	60	
WHR	0 (0.00)	2(3.44)	10(5.88)	22(7.33)	10(5.74)	2 (3.33)	0.01
Hypertension	2(20.00)	2(3.44)	2(1.17)	12(4.00)	12(6.89)	6(10.00)	0.01

*p<0.05; WHR= waist hip ratio

resulting Odds ratios (OR) and adjusted OR with 95% confidence intervals (CI) were shown in Table 7. Increase in age elevated the hypertensive (OR=0.12; 0.06, 0.26) and elevation persisted after adjustment for physical activity, socioeconomic status, and self rated health. The risk of hypertension was significantly high at BMI>25 kgm^{-2} (OR= 4.37:0.86, 22.18) followed by overweight (OR=1.34: 0.29, 6.13) when compared to underweight. Similar trend continued after adjustment for selected demographic variables. A transition with increased socio-economic gradient also elevated the risk of hypertension (OR=1.24: 0.61, 2.53) and after adjustment the risk came down to 1.15. Mild physical activity accounted a higher odds of 17 times (CI= 6.97, 41.97) and after adjustment for SES, and age the odds of hypertension came to 2.25 (CI=0.63, 8.02).

Table 7: Determinants of high blood pressure (logistic regression)

Variable	*Crude OR (95% CI)*	*Adjusted OR (95% CI)*
Age (years)		
20-39	1.00	1.00
40-59	0.01(0.001, 0.04)	0.01(0.001, 0.04)
>60	0.12(0.06, 0.26)	0.12(0.06, 0.26)
BMI Category		
<18.5	1.00	1.00
18.5-23	0.90(0.46, 1.78)	0.95(0.43, 2.09)
23-25	1.34(0.29, 6.13)	1.97(0.39, 10.08)
>25	4.37(0.86, 22.18)	4.78(0.78, 29.24)
Socio-economic Status (SES)		
SES-4	1.00	1.00
SES-3	1.24(0.61, 2.53)	1.15(0.51, 2.60)
Physical Activity		
Heavy	1.00	1.00
Moderate	2.09(0.86, 5.05)	1.16(0.43, 3.11)
Mild	17.10(6.97, 41.97)	2.25(0.63, 8.02)

*OR= odds ratios; CI= confidence intervals

DISCUSSION

In the present study the association between anthropometric parameters and blood pressure was studied in an adult female population of Andhra Pradesh. The findings reveal a positive association between BMI, WC and WHR with blood pressure levels. The researchers' findings are in good agreement with other published works (Bose and Chaudhuri 2001; Rurik et al. 2004; Turconi et al. 2006; Atallah et al. 2007; Ghosh and Bandyopadhyay 2007; Sung et al. 2007). Overall the mean levels and blood pressure and adiposity markers are comparatively lower when compared to other populations (Agyemang and Bhopal 2001; Christofaro et al. 2011). Thus the present sample is carrying less risk towards cardiovascular diseases when compared to other populations.

The linear relationships between BMI quintiles and BP are insignificant in the present sample. However an elevation is noticed with a BMI>23.0 kg/m^2 and >25.0 kg/m^2. Lack of linear correlation between BMI and BP in lean populations was reported elsewhere (He et al. 1994). The association between BMI and BP has been widely reported across populations in Asia, Latin America, United States and Canada. In a study that included five Latin American populations (urban) and seven Asian populations (four urban, three rural), significant positive relationships of similar magnitude were observed between BMI and BP, despite differences in mean BMI levels between the populations studied. The observed distribution of hypertensive's in obese suggest impaired life styles and over nutrition.

Systolic and diastolic blood pressures are positively correlated with age while BMI was not. A significant correlation between SBP and DBP with age was also reported (Orrin et al. 2010; Jesoth et al. 2012). Similarly a strong association of overall and abdominal obesity with blood pressure was also noticed (Debolina Sarkar et al. 2009). In the present sample age and overweight/obesity were identified as significant determinants of hypertension. Similar findings have been reported in other studies (Reddy et al. 2010). It is probable presumed that economic transition towards affluence might have increased the risk of hypertension. It is thus demonstrated that BMI is closely associated with BP in populations who are at different stages of socio-economic transition.

The relationship between BMI and BP in this study may possibly be confounded by cultural factors which are to be explored in light of the present findings. The low prevalence of hypertension and obesity in the presence of higher WHR necessitates undertaking in-depth studies to explore the factors which are contributing toward the low prevalence and such studies may provide ways to adopt remedial measures to maintain these insults at low profile.

The results conclude that there is a relation between obesity and blood pressure in the adult females. This is attributed to the varying socioeconomic status of the people. The present analysis also brings out new dimension and horizon for understanding the phenomenon of overweight/obesity and its intimate relationship with blood pressure. As the present study is exploratory in nature further comparative studies throw more light on the phenomena of obesity and hypertension.

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