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Internal Medicine Section

Short Communication

Effect of Gender on the Total Abdominal Fat, Intra-Abdominal Adipose Tissue and Abdominal Sub-Cutaneous Adipose Tissue among Indian Hypertensive Patients

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ABSTRACT

Introduction: Abdominal obesity is a better marker of adverse metabolic profile than generalized obesity in hypertensive subjects. Further, gender has effect on adiposity and its distribution.

Aim: Effect of gender on obesity and the distribution of fat in different sub-compartments of abdomen among Indian hypertensive subjects.

Materials and Methods: This observational study included 278 adult subjects (Males-149 & Females-129) with essential hypertension from a tertiary care centre in north India over one year. A detailed history taking and physical examination including anthropometry were performed in all patients. Total Abdominal Fat (TAF) and abdominal adipose tissue sub-compartments like Intra-Abdominal Adipose Tissue (IAAT) and Sub-Cutaneous Adipose Tissue (SCAT) were measured using the predictive equations developed for Asian Indians.

Results: Female hypertensive subjects had higher Body Mass Index (BMI) with more overweight (BMI ≥ 23kg/m^2), and obesity (BMI≥ 25 kg/m^2). Additionally, they had higher prevalence of central obesity based on both Waist Circumference (WC) criteria (WC≥ 90 cm in males and WC≥ 80 cm in females) and TAF criteria {≥245.6 cm^2 (males) and ≥203.46 cm^2 (females)} than male patients. But there was no difference in the prevalence of central obesity based on Waist Hip Ratio (WHR) criteria (WHR ≥0.90 in males and WHR ≥ 0.85 in females) between two genders. High TAF & IAAT were present in more females although there was no difference in the distribution of high SCAT between two genders.

Conclusion: Female hypertensive subjects were more obese with higher abnormal TAF & IAAT compared to male patients. However, there was no difference in the distribution of high SCAT among them.

Keywords: Body mass index, Fat distribution, Waist circumference

INTRODUCTION

Obesity and hypertension are two common and interrelated medical problems world-wide [1]. Obesity alone accounts for 78% and 65% of essential hypertension in men and women, respectively, according to data from the Framingham offspring study [2]. Abdominal obesity is related to increased risk of all-cause mortality throughout the range of Body Mass Index (BMI) [3]. Hence, fat distribution is more important than excess body weight in a subject with hypertension [4]. Even in the same subject, the various compartments of abdominal fat have different metabolic effects [4]. Therefore, it is important to know the fat distribution in abdomen among them.

The most accurate way to measure central body fat is by imagings like Magnetic Resonance Imaging (MRI), Computed Tomography (CT) or Dual-Energy X-ray Absorptiometry (DEXA) [5]. But this approach is expensive and cannot be used in routine clinical practice. Total Abdominal Fat (TAF) and abdominal adipose tissue sub-compartments like Intra-Abdominal Adipose Tissue (IAAT) and Sub-Cutaneous Adipose Tissue (SCAT) can also be calculated by using predictive equations derived from simple anthropometric parameters [6]. This distribution of abdominal fat is affected by different factors like ethnicity, age, gender, drugs and presence of obesity [4].

AIM

To the best of our knowledge, there is no literature on the fat distribution in abdomen among Asian Indian hypertensive subjects. Therefore, this study was conducted to see the effect of gender on obesity and the distribution of abdominal fat among Indian hypertensive subjects.

MATERIALS AND METHODS

This observational study included 278 consecutive hypertensive patients (>18 years) from the hypertension clinic of a tertiary care centre in north India over one year (July 2004 to June 2005). The subjects having secondary hypertension (renal, endocrine, vascular & drug induced), chronic illness, malnutrition (BMI< 18.5 kg/m^2) and long term steroid therapy were excluded. The diagnosis and management of hypertension was based on JNC VII guidelines [7]. The Institutional Ethics Committee approved the study and informed consent was obtained from all subjects in accordance with the declaration of Helsinki. A detailed history taking and physical examinations including anthropometry (height, weight, Waist Circumference (WC) & Hip Circumference (HC) were performed in all patients. Height was measured using a portable stadiometer. Each study participant stood barefoot with heels, buttocks, shoulders and occiput resting lightly against the backing board so that the Frankfurt plane (a line connecting the superior border of external auditory meatus with infraorbital rim) was horizontal (i.e. parallel to the floor). The reading was recorded to the nearest millimeter (mm). Weight was measured after removal of shoes with light clothing, using a mechanical beam balance and was recorded to the nearest 0.1 kilogram (kg). WC was measured using a steel measuring tape at the midpoint between the lower border of ribs and the top of the iliac crest in a horizontal plane at the end of expiration. HC was measured at the level of the greater trochanters. Both WC and HC were measured thrice and the average was taken to the nearest mm. Waist Hip Ratio (WHR) was defined as the WC in centimeters (cm) divided by the HC in cm. BMI was calculated by dividing the weight in kilograms by the height in meters squared. Overweight and obesity were defined as those having BMI ≥23- 24.9 kg/m^2 and BMI≥ 25 kg/m^2 respectively

[8]. Central obesity was defined either by increased WC (WC≥ 90 cm in males and WC≥ 80 cm in females) or by increased WHR (WHR ≥0.90 in males and WHR ≥ 0.85 in females) [8,9].

TAF and abdominal adipose tissue sub-compartments like Intra-Abdominal Adipose Tissue (IAAT) and Sub-Cutaneous Adipose Tissue (SCAT) were measured using the predictive equations developed for Asian Indians which included variables such as age, gender, BMI, WC, and HC [Table/Fig-1] [6]. These equations were derived from the measurements of abdominal fat and its components by MRI at L_{3-4} inter-vertebral disc level in 100 healthy adults from north India [6]. The Cut offs for high TAF {≥245.6 cm^2 (males) and ≥203.46 cm^2 (females)}, high IAAT {≥135.3 cm^2 (males) and ≥75.73 cm^2 (females)} and high SCAT {≥110.74 cm^2 (males) and ≥134.02 cm^2 (females)} developed for Asians Indians were used to determine the adiposity [10]. High TAF was also considered as one of the definition of central obesity in this study.

Parameters	Predictive equations
TAF	-47,657.00+1384.11x gender*+1466.54xBMI +416.10xWC
IAAT	-238.7+16.9xage+934.18xgender*+578.09xBMI – 441.06 xHC+434.2 x WC
SCAT	-49,376.4 – 17.15 x age +1,016.5 x gender* + 783.3 x BMI + 466 x HC

[Table/Fig-1]: Predictive equations for estimation of abdominal adipose tissue.
TAF-total abdominal fat, IAAT-intra-abdominal adipose tissue, SCAT-sub-cutaneous adipose tissue, BMI- body mass index, HC- hip circumference, WC-waist circumference.
*Male: 1; Female: 2.

STATISTICAL ANALYSIS

Statistical analysis was done using SPSS software version 17. The distribution of data was evaluated with Shapiro-Wilk test. All continuous non-normally distributed data were summarized as median with Inter-Quartile Ranges (IQR). Mann-Whitney U test was used to compare these variables. The categorical data were expressed as frequency (as percentages), which were compared using Chi-Square test. All statistical tests were two-sided and p-value <0.05 was considered as significant.

Parameters	Total (N=278)	Male (N=149)	Female (N=129)	p-value
Age (years)	47 (19)	46 (22.5)	48 (17.5)	0.206
Duration of hypertension (years)	02 (04)	02 (04)	02 (05)	0.210
Body mass index (kg/m^2)	26 (05)	26 (05)	27 (06)	0.003
Waist circumference (cm)	93 (15)	94 (14)	90 (17)	0.197
Hip circumference (cm)	100 (13)	99 (11)	100 (13)	0.013
Waist-hip ratio	0.92 (0.10)	0.96(0.10)	0.90(0.10)	<0.0001
Overweight	235 (84%)	120 (80%)	115 (89%)	0.004
Obesity	183 (66%)	92 (62%)	91 (71%)	0.04
*Central Obesity based on WC	210 (75%)	96 (64%)	114 (88%)	<0.0001
†Central Obesity based on WHR	231(83%)	124 (83%)	107(83%)	1

[Table/Fig-2]: Demographics, anthropometry &obesity profiles.
*Waist circumference (WC) ≥ 90 cm in males &≥ 80 cm in females
†Waist-hip ratio (WHR) ≥ 0.90 in males &≥ 0.85 in females

RESULTS

This study included 149 males and 129 females [Table/Fig-2]. The median age for these patients was 47 years. 80% of males and 89% of females were overweight. Majority of them were obese. The median BMI, WC and WHR were in obesity range for both genders. Twenty nine males and fourteen females had normal BMI. However, 19(65%) males and 13(93%) females with normal BMI had central obesity by using any of the three criteria (WC, WHR, or TAF). Female hypertensive subjects had higher BMI with more overweight, obesity and central obesity (based on WC or TAF criteria) than male patients [Table/Fig-2,3]. But there was no difference in the prevalence of central obesity based on WHR between two genders. However, the maximum number of hypertensive subjects had central obesity using WHR criteria (210 by WC, 231 by WHR & 228 by TAF criteria). Overall, the prevalence of central obesity was more compared to generalized obesity. Females had more TAF and SCAT compared to males [Table/Fig-3]. High TAF & IAAT were present in more females although there was no difference in the distribution of increased SCAT between two genders.

Parameters	Total (N= 278)	Male (N=149)	Female (N=129)	p-value
TAF(cm^2)	310 (132)	299(129)	334 (150)	0.021
IAAT(cm^2)	131 (62)	135 (61)	128 (63)	0.54
SCAT(cm^2)	181 (97)	167(88)	201(95)	<0.0001
High TAF (Central obesity)	228 (82%)	107(72%)	121 (94%)	<0.0001
High IAAT	194 (70%)	74 (50%)	120 (81%)	<0.0001
High SCAT	228 (82%)	121(81%)	107 (72%)	0.80

[Table/Fig-3]: Effect of gender on the distribution of abdominal fat.
TAF-total abdominal fat, IAAT-intra-abdominal adipose tissue, SCAT-sub-cutaneous adipose tissue.

DISCUSSION

The prevalence of generalized obesity based on BMI was 66% in our study. Central obesity was more prevalent than generalized obesity in this study as the former is strongly associated with various cardiovascular risk factors like hypertension. However, the prevalence of overweight was more compared to abdominal obesity. In a hospital based study by Thakur et al., from north India, 72% of the hypertensive patients had central obesity and 73.7% were overweight [11]. But the prevalence of abdominal obesity and overweight were 93% and 84% respectively among hypertensive subjects in a community study by Yadav et al., from Lucknow [12]. Forty three hypertensive subjects had normal BMI in our study. BMI within normal range was also associated with hypertension, diabetes and dyslipidaemia among Indians in various studies [12,13]. This is due to the difference in total body fat and its distribution among them compared to other ethnicities at the same BMI [4]. This may explain high prevalence of central obesity with metabolic complications among non-obese Indians. These subjects are called as metabolically obese non-obese. These people should be screened for cardiovascular risk factors before they develop overt disease.

The presence of central obesity increases the risk of cardiovascular diseases among hypertensive subjects. Its prevalence varied based on criteria used for its diagnosis. Females had higher prevalence of central obesity compared to males based on WC criteria (88% vs. 64%, p<0.0001) or increased TAF (94% vs. 72%, p<0.0001) in this study is similar to the findings by Bhardwaj et al., [14]. This is due to presence of more overweight/obese females with higher BMI in this study. At higher BMI, the chance of having increased WC or high TAF is more [9]. The study by Shimokota et al., found that changes in WC and HC correlated directly with changes in weight, but there were differences in the pattern of change by gender [15]. In men, waist changes were larger than hip changes, but in women they were similar. This fact may explain the similar prevalence of abdominal obesity based on WHR criteria in both genders in this study.

The metabolic activities of fat cells depend on its anatomic location. They are different in terms of blood supply, response to hormones, adipokines secretion and gene expression [16]. Even in abdomen, the IAAT and SCAT are metabolically different. IAAT was significantly associated with hypertension compared to SCAT and TAF in many studies [16]. It increases blood pressure by increasing insulin resistance, sympathetic and renin-angiotensin-II-aldosterone system activation [4]. Gender influences both whole body and abdominal fat distribution among hypertensive subjects [17]. Healthy adult women have more total body fat with higher SCAT and men have higher TAF with more IAAT [10]. But in our study, female hypertensive subjects had both higher median TAF and SCAT. This was due to inclusion of more obese females compared to males. However, more females had TAF and IAAT in abnormal high range compared to reference range of healthy Indian controls. This suggests that the amount of IAAT increased disproportionately in females compared to males before they became hypertensive.

LIMITATION

To the best of our knowledge, this is the first Indian study documenting the distribution of fat in different compartments of abdomen among hypertensive subjects. However, there were few limitations in this study. Relatively small numbers of subjects were included from a teaching hospital. Hence, the study conclusions may not be applicable to the population as a whole. Second, it lacks a control group of age and sex matched subjects which would have strengthened the study.

CONCLUSION

Obesity was more prevalent with higher visceral fat among Indian female hypertensive subjects compared to male patients. As visceral fat is associated with adverse cardiovascular risk factors, all female hypertensive subjects should be screened for cardiovascular diseases at the diagnosis of hypertension.

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