Indian J Physiol Pharmacol 2009; 53 (3) : 259–264

ANTHROPOMETRIC MEASUREMENTS AS PREDICTORS OF INTRAABDOMINAL FAT THICKNESS

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(Received on January 1, 2009)

Abstract : Central obesity is known to be an important risk factor in the development of metabolic syndrome and intraabdominal fat thickness has been found to be a reliable indicator of central obesity. Many anthropometric indicators have been suggested for measuring intraabdominal fat. The aim of this study was to relate various anthropometric measurements to intraabdominal fat thickness and to determine which among these is a better predictor of intra abdominal fat in normal subjects. This cross sectional study was carried out. in 60 healthy subjects (32 males and 28 females) in the age group of 25–55 years. Anthropometric measurements such as BMI, waist circumference and waist-hip ratio were assessed by using standard methods. Subcutaneous and visceral fat were measured 1 cm above umbilicus by ultrasonography. Intraabdominal fat thickness was correlated with the anthropometric measures by Pearson's test. Multivariate linear regression test was used to find the best anthropometric measurement as a predictor of abdominal fat. Waist circumference showed a significant positive correlation with subcutaneous fat and visceral fat. Waist circumference was found to be the best predictor of intraabdominal fat thickness in normal subjects and therefore of central obesity.

Key words : central obesity anthropometry intra abdominal fat waist circumference visceral fat

INTRODUCTION

Obesity is a major public health problem, the prevalence of which has increased worldwide and it significantly increases morbidity and mortality of any given population (1, 2). Central obesity is known to be an important risk factor in development of metabolic syndrome, atherosclerosis and other cardiovascular diseases (3, 4). Intraabdominal fat thickness i.e. visceral abdominal adipose tissue has been found to

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be a reliable indicator of the central obesity. Subcutaneous abdominal adipose tissue (SAT) is also proved to correlate with obesity. Measurement of such fat accumulation is an important step in assessing obesity. The important implication of abdominal fat measurement is the potential for intervening more intensively to reduce the high cardiovascular risk attributed to those patients. Accurate quantification of intraabdominal fat requires imaging techniques such as magnetic resonance imaging (MRI), computed tomography (CT) and ultrasonography (US) (5, 6). However, these techniques are relatively expensive and complex, and are impractical for routine clinical settings or large-scale studies. Simple clinical anthropometric measurements, such as WC (Waist Circumference), WHR (Waist Hip ratio) and BMI (Body Mass Index) may be conveniently used to assess central obesity. It is essential to identify the best anthropometric index in any population to predict intra abdominal fat and therefore central obesity. However, the relative abilities of WC, WHR and BMI to predict intra abdominal fat accumulation still remain unclear. Therefore the present work was undertaken to relate the various anthropometric measurements to intra abdominal fat thickness and to determine the best anthropometric parameter as a predictor of intra abdominal fat in normal individuals.

The aim of the present study was to investigate the relationship between anthropometric measures of obesity (WC, WHR and BMI) and intra abdominal fat, subcutaneous abdominal adipose tissue (SAT) and visceral abdominal adipose tissue (VAT) measured by ultrasonography in normal subjects.

MATERIALS AND METHODS

Subjects

Sixty healthy non-obese volunteers randomly selected from the community, 32 were males and 28 were females with the mean age of 29.95±5.50 and 31.38±5.34 (range 25–55 years) constituted the study subjects. Subjects with a history of smoking, on drugs known to affect lipid metabolism, familial dyslipidaemia, upper abdominal surgery and medical disorders were excluded. Written informed consent was obtained from every subject. The study was approved by the Institutional Ethics Committee.

Anthropometric measures

In this cross-sectional study, participants in a fasting state underwent anthropometric evaluation and abdominal US. Anthropometrical measurements evaluated included weight, height, waist circumference and hip circumference. Weight was obtained using calibrated electronic scales (*Filizola, Brazil*) while subjects wore light clothing and no shoes, height was measured with a fixed stadiometer. BMI was calculated as weight divided by height square. WC was measured in orthostatic position at the midpoint between the lateral iliac crest and lowest rib, and hip circumference was measured at the level of the trochanter major.

Ultrasound image analyses

All ultrasonographic procedures were performed by the same examiner using a 3.5-MHz probe located 1 cm from the umbilicus. Two US measurements of VAT and SAT were taken. US-determined subcutaneous fat was defined as the distance between the skin and external face of the rectus abdominis muscle, and visceral fat was defined as the distance between the internal face of the same muscle and the anterior wall of the aorta (7).

Statistical analysis

The Statistical software namely SPSS 11.0 and Systat 8.0 were used for the analysis of the data. The data were expressed as arithmetic means±SD. Student's 't' test was used to compare the mean. Pearson's correlation analysis was used to assess the degree of relationship of anthropometrical indicators with VAT and SAT. Multivariate linear regression analysis was used to assess the prediction efficiency of study parameters with VAT and SAT. Statistical significance was defined at the 5% level.

RESULTS

Table I shows the baseline characteristics of the study population. Total subjects studied were 60, 32 males and 28 females. No significant difference was observed between males and females with respect to VAT and SAT.

Table II shows the degree of relationship of study parameters with BMI, WC & WHR in males, females and in total subjects. BMI shows a significant positive correlation with SAT than with VAT. WC shows a significant positive correlation both with SAT and VAT. WHR shows no significant correlation with abdominal adipose tissue in all the groups.

TABLE I: Comparison of Mean and SD values of study parameters.

Study parameters	*Male*		*Female*		*All subjects*		*P value*
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	
Age in years	29.95	5.50	31.38	5.34	30.38	5.44	0.385
Height in cm	168.74	5.97	156.44	10.14	165.03	9.32	<0.001**
Weight in kg	64.51	11.76	49.69	4.80	60.04	12.23	<0.001**
BMI (kg/m^2)	22.64	3.86	20.60	3.98	22.02	3.97	0.087
Waist circumference (cm)	84.49	10.06	67.94	10.67	79.49	12.72	<0.001**
HIP circumference (cm)	91.05	12.21	85.00	4.83	89.23	10.86	0.062
Waist-hip ratio	0.94	0.12	0.80	0.11	0.90	0.13	<0.001**
Subcutaneous Fat-CSF (cm)	1.73	0.53	1.53	0.67	1.67	0.58	0.260
Visceral Fat-VF (cm)	3.69	0.86	3.60	0.86	3.67	0.85	0.725

**Significant at 1%.

TABLE II: Correlation between study parameters in study subjects.

Study parameters	*BMI (kg/m^2)*		*WC (cm)*		*WHR*	
	r value	*P value*	*r value*	*P value*	*r value*	*P value*
Male						
SAT (cm)	0.644	<0.001**	0.747	<0.001**	–0.054	0.751
VAT (cm)	0.410	0.012*	0.468	0.003**	–0.230	0.172
Female						
SAT (cm)	0.716	0.001**	0.738	0.001**	0.650	0.06
VAT (cm)	0.360	0.171	0.575	0.020*	0.348	0.196
All subjects						
SAT (cm)	0.677	<0.001**	0.619	0.001**	0.215	0.122
VAT (cm)	0.395	0.003**	0.629	<0.001**	–0.045	0.750

*Significant at 5%; **Significant at 1%.

TABLE III : Multivariate linear regression analysis of anthropometric parameters with visceral fat and subcutaneous fat.

	Male		*Female*		*All subjects*	
	Regression coefficient (Standardized)	*P value*	*Regression coefficient (Standardized)*	*P value*	*Regression coefficient (Standardized)*	*P value*
VAT dependent						
BMI (kg/m^2)	–0.033	0.858	0.749	0.028	–0.017	0.928
WC (cms)	0.870	<0.001**	1.385	0.001**	0.743	0.001**
WHR	–0.317	0.010*	–1.284	0.039*	–0.505	0.02*
Co-efficient of determination (R^2)	64.6%	<0.001**	73.0%	<0.001**	34.9%	<0.001**
SAT dependent						
BMI (kg/m^2)	–0.136	0.574	0.540	0.064+	0.281	0.069
WC (cms)	0.710	0.001**	2.380	<0.001**	0.631	0.001**
WHR	–0.440	0.007*	–2.340	0.006**	–0.271	0.036*
Co-efficient of determination (R^2)	37.8%	0.001**	74.8%	<0.001**	57.2%	<0.001**

*Significant at 5%; **Significant at 1%.

Table III shows Multivariate linear regression analysis to assess the prediction efficiency of study parameters with visceral fat and subcutaneous fat. WC is found to be a positive significant predictor both for SAT and VAT (P<0.001) in all the groups. WHR is a negative predictor of abdominal fat, but less significant than WC (P<0.05). BMI has no significant prediction efficiency (P>0.05). Regression models fitted for VAT and SAT based on BMI, WC and WHR is significant.

DISCUSSION

The present study suggests that in normal subjects WC is a better predictor of the VAT than WHR and BMI. Specifically, WC predicted VAT and SAT better than BMI and WHR. When segregated based on sex, both males and females showed statistically significant positive correlation of WC with SAT and VAT. (Table II and III). Accumulation of fat in the intraperitoneal or subcutaneous abdominal regions has been strongly linked with insulin resistance and dyslipidaemia (3). Although accurate quantification of body fat compartments with imaging techniques can predict metabolic abnormalities, it is impractical for routine clinical practice or larger scale studies. Our results suggest that measurement of WC could be used as a better overall surrogate index of intra abdominal fat than WHR or BMI.

In the present study abdominal adipose tissue was measured by ultrasonography. The use of US in the assessment of intra-abdominal fat, initially proposed by Armellini et al (7), was further confirmed by strong correlations with the CT-determined visceral fat area (8, 9).

Several studies have examined the association of conventional anthropometrical measures with regional abdominal adipose tissues in obesity (10, 11). Undoubtedly, BMI is the most common method for estimating body fat, and several epidemiological studies have reinforced its role in the prediction of morbidity and mortality (1, 2). BMI has been conventionally used to define and classify overweight and obesity. However, BMI does not account for the wide variation in body fat distribution, and has considerable limitations in predicting intra-abdominal fat accumulation (12). An increased BMI does not show which body compartment (fat or lean mass) is inadequate and cannot differentiate subcutaneous from visceral fat accumulation. This would explain why populations with low-prevalence rates of obesity could show a high incidence of diseases linked with insulin resistance (12, 13). Although our study detected a significant correlation of BMI with visceral fat, the coefficient was much stronger with subcutaneous fat, which suggested inaccuracy of this index in assessing adipose tissue distribution. Consistent with this, we found that BMI had a weaker association with VAT and SAT than WC. In case of males there was a significant positive correlation of BMI with both SAT and VAT when compared to females where BMI was positively correlating with SAT not with VAT (Table II).

The WHR is also a practical index of regional adipose tissue distribution and has been widely used to investigate the relations between regional adipose tissue distribution and metabolic profile (14). As seen in Table II, WHR showed no significant correlation with both VAT and SAT in case of males and females as well as in all subjects. The WHR value does not account for large variations in the level of total fat and abdominal visceral adipose tissues (15). Moreover, it requires two measurements, waist and hip circumference, which may contribute to summative measurement error. On the other hand, WC is a convenient and simple index that determines the accumulation of abdominal adipose tissue (12). Simplicity, low cost, and acceptable accuracy have led to the use of waist circumference in several epidemiological studies as an indicator of cardiovascular risk (16, 17). Accordingly, WC has been shown to be a preferred index over the WHR to estimate the amount of abdominal adipose tissues (11, 15), consistent with the present findings where WC is having a better prediction value of abdominal fat than WHR (Table III).

Our study does have limitations. The relatively small sample size of the present study might have been underpowered to demonstrate the true strength of the association between the anthropometric and US variables. Only about 60% of the regional adipose tissue mass could be accounted for the anthropometric indices employed in our study, reflecting the inherent limitations of these indices as predictor variables. It might therefore have been useful to employ other simple techniques to assess fat mass, such as skin fold thickness and dual energy absorptiometry. However, these techniques do not also allow detailed assessment of the all-individual adipose tissue compartments under investigation. Another limitation of this study is related to the inclusion of only non-obese subjects. Therefore, the conclusions of our study cannot be extended to obese subjects.

We conclude that WC seemed to be the best alternative method for the assessment of intra-abdominal fat deposition in non-obese subjects. However, prospective epidemiological studies are needed to establish CT and US cut-off points to define visceral fat levels related to elevated cardiovascular risk.

In conclusion, our results confirm the importance of the WC as a surrogate marker of the distribution of adiposity in the abdominal region in normal subjects. Accordingly, we propose that WC is probably the most convenient and reliable clinical measure of abdominal fat compartments. Whether our conclusions also apply to younger age groups, obese subjects and other racial groups with different body habitus, merits further investigation.

ACKNOWLEDGEMENTS

We thank the Association of Physiologists and Pharmacologists for awarding Harish Gupta National Award for the presentation of this study. We are grateful to Dr. S. Kumar, Principal of M.S.R.M.C. for his constant encouragement. We acknowledge Dr. K.P. Suresh, Scientist (Statistics), National Institute of Animal Nutrition & Physiology, Bangalore for the data analysis.

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