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Association of Obesity Indices with Type 2 Diabetes Mellitus and Coronary Artery Disease

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ABSTRACT India is the diabetes capital of the world. Asian Indians have an increased predilection not only to diabetes but also to coronary artery disease (CAD). Obesity is an independent risk factor for the development of diabetes and CAD. Body mass index (BMI), waist/hip ratio (WHR), waist circumference (WC) and percent body fat (%BF) are the various variables used to measure obesity. The present study was attempted to clarify whether these obesity measures are associated with CAD in diabetic patients of Amritsar (Punjab). This study included 190 subjects divided into four groups: 47 patients with type 2 diabetes and CAD, 50 patients having only type 2 diabetes (without CAD), 46 CAD patients (without diabetes) and 47 healthy age and sex-matched controls. Student's t-test was used to compare the means of various variables and Pearson's correlation coefficient of all the variables with CAD was calculated. Significant difference was observed for BMI, WHR, WC and % BF between non-diabetic CAD patients and controls. On the other hand, only % BF showed significant difference when diabetic patients with and without CAD were compared. BMI, WHR, WC and % BF showed significant correlation with CAD in non-diabetic subjects. However, only % BF showed a significant correlation with CAD in diabetic patients. Therefore, % BF can be used as a CAD marker in diabetic as well as non-diabetic subjects. BMI, WHR and WC can act as indicators of CAD in the non-diabetic population but not in the diabetic subjects. Larger prospective studies are needed to confirm these findings.

INTRODUCTION

Diabetes mellitus, a global public health problem, is now emerging as a pandemic. India is the diabetes capital of the world with 41 million Indians having diabetes, every fifth diabetic in the world being an Indian (Joshi and Parikh 2007). Type 2 diabetes mellitus (T2DM), in particular, is a progressive macrovascular disease, with universally established excessive predilection for coronary artery disease (CAD) irrespective of race, ethnicity and gender.

It is well documented (Stamler et al. 1993; Haffner et al. 1998; Abbas et al. 2008) that diabetic patients are more prone to develop microvascular and macrovascular diseases leading to increased mortality. Although atherosclerotic plaques in the two groups are similar, diabetics have more severe and diffuse disease than non-diabetics (Hurst and Lee 2003). Asian Indians have an increased predisposition not only to diabetes but also to CAD (Reddy and Yusuf 1998; Wild et al. 2004). It has been predicted that by 2020 there would be a 111% increase in cardiovascular deaths in India (Murray and Lopez 1997).

Several studies have revealed that obesity has a harmful influence on the cardiovascular system, increasing the mortality associated with cardiovascular disease (Romero-Corral et al. 2006). An increased accumulation of fat in the intraabdominal cavity, termed visceral adiposity, is highly correlated with an adverse coronary risk profile. Body weight, body mass index (BMI), waist circumference (WC) and waist–hip ratio (WHR) are primary methods to determine obesity. More recently, bioelectrical impedance assessment (BIA) has been used in the measurement of obesity. Asian Indians have a low average body mass index (20–30 kg/m^2) and low rates of obesity (10–15%) in association with higher prevalence of cardiovascular disease and diabetes (Snehalatha et al. 2003).

Most of the previous studies evaluating the relationship between CAD and obesity were carried out in general (healthy) population. However, the correlation of BMI and other markers of obesity with CAD in diabetic patients has not been well studied. Therefore, in the present study, an attempt has been made to clarify whether BMI, WHR, WC and percent body fat are associated with CAD in diabetic patients of Amritsar (Punjab).

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METHODOLOGY

The ethical committee of Guru Nanak Dev University, Amritsar, approved the present study. All the patients were recruited from two hospitals (Dr. A.P. Singh Heart Care Centre and Mata Kaulan Hospital) at Amritsar (Punjab, India) after informed consent. Anthropometric measurements (height, weight, waist and hip circumference) were taken on all the subjects using the standardized methodology given by Weiner and Lourie (1981). BMI and WHR were derived using these anthropometric data. A body fat analyzer (Body Stat 1500) determined body composition in all subjects using bioelectric impedance analysis (BIA). Blood pressure measurements were taken on each subject in accordance with WHO guidelines using sphygmomanometer. This case-control study included 190 subjects that were divided into following four groups:

Group 1 composed of 47 patients with type 2 diabetes and CAD of which 23 were males and 24 were females. Diagnosis of type 2 diabetes was based on the criteria established by WHO (1999) i.e. fasting plasma glucose ≥126mg/dl and/or 2-hour post glucose ≥200mg/dl. The diagnosis of CAD was based on the following criteria: a) definite history of an episode of myocardial infarction b) definite history of angina pectoris with documented ECG findings and under specific therapy c) electrocardiographic findings, namely the Minnesta codes 1-1, 4-1, 5-2, or 9-2. The physician made all the diagnoses.

Group 2 included 50 type 2 diabetic patients without CAD (25 males and 25 females). All the subjects in this group denied any history of angina, myocardial infarction or any vascular disease and had normal resting ECGs.

Group 3 comprised of 46 non-diabetic subjects with CAD, including 23 males and 23 females.

Group 4 consisted of 47 (24 males and 23 females) age and sex matched control subjects i.e. normal individuals without any history of diabetes or CAD. The inclusion criteria were normal glucose tolerance, absence of angina, myocardial infarction, or history of any vascular disease and a resting 12-lead ECG.

Results were expressed as mean±SD for each sex. Student's t-test was used to compare the means of various variables. Pearson's correlation coefficient (r) of all the variables with CAD was also calculated.

RESULTS

Table 1 shows the baseline characteristics of the study groups. The mean duration of diabetes in males and females with type 2 diabetes and CAD was 10.24±6.43 and 8.67±5.53 years respectively. On the other hand, duration of diabetes was significantly lower in diabetic patients without CAD i.e. 3.55±2.67 years in males and 4.08±2.87 years in females.

Mean value of systolic blood pressure (SBP) and diastolic blood pressure (DBP) was significantly higher in diabetic males with CAD than that for diabetic males without CAD. In addition, in the non-diabetic group, DBP and SBP were significantly higher in subjects with CAD as compared to those without CAD.

Mean value of BMI was 27.21±3.61 kg/m² for diabetic males with CAD which was higher than that for diabetic males without CAD (26.71±4.05 kg/m²), but the difference between the two was not statistically significant. Similarly, the mean values of BMI did not differ significantly among diabetic females with CAD and diabetic females without CAD (28.16±4.04 kg/m² vs 26.81±4.35 kg/m², respectively). On the other hand, in case of non-diabetic group, patients with CAD had significantly higher BMI values than those without CAD (Table 1).

No significant difference was observed for WHR and WC among diabetic patients with CAD and diabetic patients without CAD. However, in case of non-diabetic group, WHR and WC of patients with CAD were significantly higher than those without CAD. Male diabetic subjects with CAD had significantly higher percent body fat (36.87 ±4.07%) as compared to male diabetic subjects without CAD (30.08±6.94%). In addition, significant difference was observed for percent body fat among female diabetic subjects with and without CAD (40.23±2.33% vs 37.32±5.95%, respectively). Amongst the non-diabetic subjects, significant difference was observed for percent body fat between subjects with CAD and without CAD for both the sexes (Table 1).

Results of the Pearson's correlation analysis (Table 2) showed that BMI, WHR, WC and percent body fat had a strong correlation with CAD among non-diabetic males and females. However, only percent body fat showed significant correlation with CAD in diabetic patients.

Table1: General and anthropometric characteristics of the study groups.

Parameter	*Males*						*Females*					
	Group1 (n=23)	*Group2 (n=25)*	*P*	*Group3 (n=23)*	*Group4 (n=24)*	*P*	*Group1 (n=24)*	*Group2 (n=25)*	*P*	*Group3 (n=23)*	*Group4 (n=23)*	*P*
Age (yrs)	58.13± 7.85	50.64± 13.27	<0.05	59.26± 10.35	59.96± 9.22	-	60.24± 5.34	50.53± 10.13	<0.001	58.62± 9.88	58.73± 6.94	-
Diabetes duration (yrs)	10.24± 6.43	3.55± 2.67	<0.001	-	-	-	8.67± 5.53	4.08± 2.87	<0.001	-	-	-
SBP (mm Hg)	146.06± 15.88	135.80± 18.23	<0.05	146.17± 13.02	130.67± 16.62	<0.001	142.52± 11.91	133.61± 13.72	<0.025	150.43± 15.51	126.65± 13.16	<0.001
DBP (mm Hg)	87.17± 5.80	83.20± 7.48	<0.05	87.74± 6.69	81.25± 5.37	<0.001	84.17± 6.37	82.14± 8.76	NS	89.13± 5.15	81.74± 7.17	<0.001
Weight (kg)	71.68± 9.54	70.72± 10.85	NS	73.78± 7.47	69.33± 9.29	NS	68.02± 10.56	65.14± 11.06	NS	73.26± 10.03	68.17± 9.59	NS
WC(cm)	97.59± 4.54	93.78± 8.25	NS	94.02± 4.90	90.56± 6.12	<0.05	97.25± 9.01	93.37± 8.30	NS	92.95± 5.34	86.35± 9.65	=0.005
BMI (kg/m^2)	27.21± 3.61	26.71± 4.05	NS	27.16± 3.39	24.91± 2.97	<0.05	28.16± 4.04	26.81± 4.35	NS	28.65± 3.33	25.92± 2.04	<0.001
WHR	1.00± 0.05	0.99± 0.05	NS	0.97± 0.05	0.93± 0.03	<0.05	0.98± 0.04	0.97± 0.06	NS	0.95± 0.06	0.91± 0.04	<0.025
% BF	36.87± 4.07	30.08± 6.94	<0.001	30.02± 4.89	24.33± 4.81	<0.001	40.23± 2.33	37.32± 5.95	<0.05	35.80± 6.86	29.75± 5.44	<0.005

Data are Mean±SD
Group1: Patients with T2DM and CAD, Group 2: Patients with T2DM, Group 3: Patients with CAD, Group 4: Healthy controls
SBP =Systolic Blood Pressure, DBP =Diastolic Blood Pressure, WC= waist circumference, BMI = body mass index, WHR= waist hip ratio, % BF =Percent body fat, NS= Non-significant

Table 2: Pearson's correlation analysis of various anthropometric variables with CAD in the study groups.

Parameter	*Diabetic subjects*				*Non-diabetic subjects*			
	Males		*Females*		*Males*		*Females*	
	r	*P*	*r*	*P*	*r*	*P*	*r*	*P*
Weight (kg)	0.046	NS	0.134	NS	0.259	NS	0.186	NS
WC(cm)	0.277	NS	0.211	NS	0.303	<0.05	0.320	<0.05
BMI (kg/m^2)	0.059	NS	0.161	NS	0.339	<0.05	0.455	<0.005
WHR	0.279	NS	0.048	NS	0.342	<0.05	0.368	<0.05
%BF	0.516	<0.001	0.313	<0.05	0.513	<0.001	0.449	<0.005

r= Coefficient of correlation
WC= waist circumference, BMI = body mass index, WHR= waist hip ratio, % BF =Percent body fat, NS= Non-significant

DISCUSSION

In the present study, a significant difference was observed for BMI, WHR and WC between non-diabetic CAD patients and controls. It is evident from table 2 that BMI, WHR and WC showed a significant correlation with CAD in non-diabetic subjects. Several previous studies have shown that obesity is an independent risk factor for the development of cardiovascular atherosclerosis (Manson et al. 1990; Jousilahti et al. 1999; Wlodarczyk and Strojek 2008). The Framingham Heart Study showed that an elevated BMI was associated with an increased risk of heart failure and estimated that 11-14% of cases of heart failure could be attributed to obesity alone (Kenchaiah et al. 2002; Massie 2002). In a study on non-diabetic South Indian men, Snehalatha et al. (2001) reported that subjects with CAD had higher obesity levels. Nishtar et al. (2004) reported that WHR could be used to predict the risk of CAD in native Pakistani population. Many recent studies have suggested that waist circumference has an independent association with the risk of diabetes and CAD (Snijder et al. 2004).

No significant correlation of BMI, WHR and WC with CAD was observed in diabetic patients. Several studies on Western populations (Knowler et al. 1991; Sprafka et al. 1993; Bo et al. 1999) show that obesity in type 2 diabetic patients is not associated with an increased prevalence of CAD indicating that once diabetes develops, other factors might become more important in the development of CAD. According to the United Kingdom Prospective Diabetes Study (Turner et al. 1997), obesity (expressed as raised BMI or WHR) was not associated with CAD in diabetic patients. Another prospective study (Klein et al. 1997) suggested that obesity in persons with older onset diabetes was not related to the long-term incidence of microvascular and macrovascular complications. Morricone et al. (1999) reported that CAD was associated with WHR, not with BMI, only in non-diabetic patients and CAD of diabetic obese patients was shown to be unrelated to BMI and parameters of fat distribution. According to Tseng (2003), no significant association was seen between CAD and waist circumference in Chinese type 2 diabetic patients in Taiwan. In a study on South Indian population, Deepa et al. (2007) reported that waist circumference was a better marker of obesity-related metabolic risk than BMI. However, some studies have reported obesity to be significantly associated with CAD in diabetic patients (Achari et al. 2006, Tseng 2006).

In the present study sample, percent body fat showed a significant correlation with CAD in non-diabetic as well as diabetic subjects. Tseng (2003) reported that percent body fat (measured by BIA) was a better predictor for CAD than BMI and WHR in type 2 diabetic patients. Singh et al. (1999) reported that high and moderate body fat percent subjects were associated with high prevalence of CAD and various coronary risk factors. It has been recommended (Bhat et al. 2005) that risk assessment for chronic diseases in Indians should be done by measuring adiposity by anthro-pometry (multiple skinfolds) or BIA (calibrated for Indians) rather than relying only on BMI cut-points.

CONCLUSION

It is evident from the present study that none of the obesity indices (BMI, WHR and WC) other than percent body fat is significantly correlated with CAD in diabetic patients. Individuals with CAD and type 2 diabetes mellitus have exaggerated central (visceral) fat distribution. Visceral fat would not be properly reflected by either BMI or WHR. The main assumption of BMI guidelines is that body mass, adjusted for stature squared, is closely associated with body fatness and consequently morbidity and mortality (Bray 1996). However, some individuals who are not overweight are not over fat and others can have BMIs within the normal range with high percentage of their body weight as fat. The measurement of WHR as a surrogate marker for visceral obesity has also been questioned in several studies (Houmard et al. 1991). WHR predicts adipose tissue volume with an error of at least 15-20%.

Hence, the findings of the present study support the hypothesis that percent body fat is an improved phenotypic characteristic over BMI and WHR when obesity related health risk is considered. The traditional obesity indices (i.e. BMI and WHR) can act as indicators of CAD in the non-diabetic population but not in the diabetic subjects. Larger prospective studies are needed to confirm these findings.

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