Original Article

Central Obesity

Central Obesity as a Risk Factor for Impaired Glucose Tolerance

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ABSTRACT

Objectives: To examine the association of central obesity (measured as waist-to-hip ratio) with glucose intolerance, and to compare the mean fasting blood sugar and the mean random blood sugar levels of centrally obese and non-obese adults.

Study Design: Analytical case-control study

Place and Duration of Study: This study was carried out at the Medical Wards and OPDs of Civil Hospital Karachi from June 2015 to December 2015.

Materials and Methods: The subjects were selected by non-probability convenience. Based on their waist-to-hip ratio they were divided into centrally obese (group A) and non-obese (group B). The cut-off point for waist-to-hip ratio was 1.0 for males and 0.85 for females. One hundred non-diabetic, healthy adults were included in each group. All the subjects underwent a 2 hour 75-gm oral glucose tolerance test. Fasting blood sugar and random blood sugar at two hours post-glucose challenge were measured.

Results: Five individuals had blood sugar levels in the diabetic range and were excluded from the study. Impaired glucose tolerance was observed in fifteen out of 98 subjects in the centrally obese group and six out of 97 subjects in the non-obese group. This difference was statistically significant ($p=0.04$). Statistically significant difference was also observed between the mean fasting blood sugar and the mean random blood sugar of the two groups ($p<0.001$ in both cases). The odds ratio for a person with central obesity to have impaired glucose tolerance was estimated to be 2.74.

Conclusion: There is a significant association between central obesity (waist-to-hip ratio) and glucose intolerance.

Key Words: obesity, waist-to-hip ratio, glucose intolerance

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INTRODUCTION

Obesity is associated with significant increases in both morbidity and mortality.[1,2] A number of diseases including type 2 diabetes mellitus (T2DM), hypertension, hyperlipidemia, coronary artery disease, metabolic syndrome, osteoarthritis and psychosocial disabilities are more prevalent in the obese.[3,4,5] Certain cancers (colo-rectal and prostate in males; uterus, ovary, biliary tract and breast in females), thromboembolic disorders and digestive tract diseases (gallstones, reflux esophagitis) occur with greater frequency in the obese.[6,7] Obesity is a major risk factor for T2DM and impaired glucose tolerance.[8,9,10] The incidence of T2DM has risen to an alarming level in our country and poses a huge health burden.[11,12]

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According to WHO estimates of the prevalence of diabetes in 1995, Pakistan was number eight in the world with a population of 4.3 million diabetics. It is estimated that by the year 2025 Pakistan will be ranked fourth with a population of 14.5 million diabetics.[13]

Impaired glucose tolerance (IGT) is a transitional stage between normal glucose tolerance and blatant diabetes. Hence people with impaired glucose tolerance form an important target group for interventions aimed at preventing diabetes mellitus.[14] In general, body mass index (BMI) has been consistently associated with T2DM and impaired glucose tolerance. However, recent studies have indicated that central obesity, as assessed by waist circumference or waist–to–hip ratio (WHR), is a more sensitive index of the risk of having impaired glucose tolerance and T2DM.[15,16,17]

According to International Diabetes Federation estimates, 193 million people with diabetes are undiagnosed and are therefore at greater risk of developing complications.[18] Moreover one in 15 adults is estimated to have impaired glucose tolerance. The purpose of this study was to identify individuals at high risk of having impaired glucose tolerance, by obtaining simple anthropometric measurements. In this way we may be able to recommend measures of primary prevention, like weight loss and lifestyle modification, for high-risk obese people.[19]

MATERIALS AND METHODS

An analytical case-control study was conducted in the medical wards and outpatients department of Civil Hospital Karachi, with the help of house officers and post-graduate students. A total of 200 individuals were initially included in the study. They were divided into two sub- groups, obese and non-obese, each containing 100 individuals. Subjects were picked up by non-probability convenience. The participants of the study were not among the patients who attended the hospital but instead their healthy attendants and members of the hospital staff.

Individuals of both sexes with ages between 25 and 60 years, no personal or family history of diabetes mellitus or hypertension and no intercurrent illness were included in the study. Known diabetics, hypertensives, first degree relatives of diabetics, pregnant females, patients suffering from any acute or chronic illness, people taking medications that affect glucose metabolism and subjects discovered to be diabetic after the glucose tolerance test were excluded from the study.

A brief history and routine clinical examination were recorded on a pre-designed proforma. Waist and hip circumferences were measured while the subjects were standing, by specially trained doctors. Waist-to-hip ratio was calculated as waist circumference divided by hip circumference.

$$WHR = \frac{\text{waist circumference (cm)}}{\text{hip circumference (cm)}}$$

After determining the WHR, the subjects were divided into two groups as follows:

Group A (centrally obese)

Males	WHR > 1.0
Females	WHR > 0.85

Group B (non-obese)

Males	WHR $\leq$ 1.0
Females	WHR $\leq$ 0.85

A total of 100 individuals were included in each group. The metabolic status of all the subjects was assessed by a standardized 2 hour 75-gm oral glucose tolerance test (OGTT) as follows:

After an overnight fast, a venous blood sample was drawn to measure the fasting blood sugar (FBS). 75 grams of glucose dissolved in 300 ml of water was then administered to the subjects. The subjects were not allowed to eat anything for two hours, after which another venous blood sample was drawn to measure the post glucose challenge random blood sugar (RBS). Results were interpreted in accordance with the World Health Organization and International Diabetes Federation criteria.[20]

- Normal glucose tolerance (NGT) was defined as FBS less than 110 mg per deciliter and RBS at two hours post glucose challenge less than 140 mg per deciliter.
- Impaired glucose tolerance (IGT) was defined as FBS level of 110 to 125 mg per deciliter (also known as impaired fasting glucose - IFG) and/or RBS at two hours post glucose challenge in the range of 140 to 199 mg per deciliter.
- Diabetes mellitus was defined as FBS level of 126 mg per deciliter or higher, or RBS at two hours post glucose challenge 200 mg per deciliter or higher (these individuals were excluded from the study).

All blood sugar measurements were done on Microlab–200 Analyzer at the Clinical Laboratory of Civil Hospital Karachi. Data analysis was done using the SPSS computer software, version 16.0. Categorization of the subjects on the basis of WHR (centrally obese / non-obese) was taken as the independent variable while FBS, RBS at two hours post-glucose challenge and inference of the glucose tolerance test were the dependent variables.

RESULTS

The demographic characteristics of the study population are summarized in Table 1. A total of 200 individuals were initially included in the study. Based on the WHR they were categorized into centrally obese (group A) and non-obese (group B). The results of the oral glucose tolerance test are summarized in Table 2.

Group A comprised of 43 males and 57 females. After the glucose tolerance test, blood sugar levels of two of them (one male and one female) were found to be in the diabetic range. These two were excluded from the study. The mean age (±SD) of the remaining 98 subjects was 40.23 (±9.77) years. Their mean FBS and RBS were 87.7 (±12.52) mg% and 130.49 (±20.77) mg% respectively. Fifteen subjects (six males and nine females) had impaired glucose tolerance. Impaired fasting glucose was concurrently seen in five of these 15 subjects. Impaired fasting glucose was not observed in any subject with normal post glucose challenge RBS.

Group B consisted of 54 males and 46 females. One female and two males were discovered diabetic after the glucose tolerance test and were excluded from the study. The mean age of the remaining 97 subjects was 36.70 (±9.15) years. The mean FBS and RBS were 77.92 (±11.56) mg% and 116.82 (±17.07) mg % respectively. Six subjects (three males and three females) had impaired glucose tolerance. Impaired fasting glucose was observed in only one female, who concurrently had impaired post glucose challenge RBS as well.

The overall frequency of impaired glucose tolerance in the study population was 10.8% (21 out of 195 subjects). Only six individuals (6.2%) in the non-obese group had IGT as opposed to fifteen individuals (15.3%) in the obese group (Figure 1). As assessed by the Chi-square test (Table 3), this difference was statistically significant (p=0.04).

Table No.1: Demographics of the Study Population

Total No. of Subjects	195
Group A (Obese)	98
Males	42
Females	56
Group B (Non-obese)	97
Males	52
Females	45
Mean Age in Years (±SD)	
Group A	40.23 (±9.77)
Group B	36.70 (±9.15)

Table No.2: Results of the Oral Glucose Tolerance Test

Study Group			Metabolic Status*		Total
			NGT	IGT	
Group A	Male	Count	36	6	42
		% within sub-group	85.7%	14.3%	100%
	female	Count	47	9	56
		% within sub-group	83.9%	16.1%	100%
	total	Count	83	15	98
		% within study-group	84.7%	15.3%	100%
Group B	Male	Count	49	3	52
		% within sub-group	94.2%	5.8%	100%
	female	Count	42	3	45
		% within sub-group	93.3%	6.7%	100%
	total	Count	91	6	97
		% within study-group	93.8%	6.2%	100%
Total		Count	174	21	195
		% of study population	89.2%	10.8%	100%

***NGT** - Normal Glucose Tolerance, **IGT** - Impaired Glucose Tolerance

Table No.3: Tests of Statistical Significance

Variable	Group A (obese) n=98	Group B (non-obese) n=97	Chi-square test value	t-test value	p-value*	Odds Ratio
Number of subjects with IGT	15 (15.3%)	6 (6.2%)	4.22	—	0.04	2.74
Mean FBS in mg%	87.7 (±12.52)	77.92 (±11.56)	—	5.67	<0.001	—
Mean RBS in mg%	130.49 (±20.77)	116.82 (±17.07)	—	5.012	<0.001	—

*statistically significant at p<0.05

The odds ratio for a person with central obesity to have IGT was estimated to be 2.74. Statistically significant difference was also observed between the mean FBS (p<0.001) and the mean RBS (p<0.001) of the two groups as assessed by students t-test. Centrally obese individuals had significantly higher values of FBS and RBS at two hours post-glucose challenge.

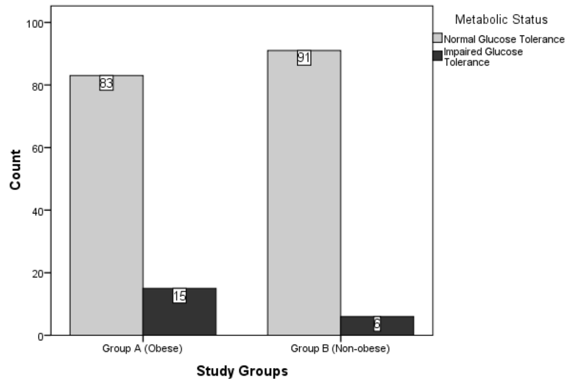

Figure No.1. Comparison of Metabolic Status of the Study Groups

DISCUSSION

The study provides evidence of a statistically significant association between central obesity and glucose intolerance. People who had a WHR above the normal limits were more likely to have impaired glucose tolerance as compared to those with normal WHR (p=0.04). Similar findings were reported in a number of other studies. Shera A and colleagues[12] performed a survey to determine the prevalence of diabetes mellitus and IGT in the NWFP. The overall frequency of IGT they reported (9.4%) was quite similar to our study. Sekikawa A and colleagues[10] in their study of a sample population of Japan reported a significant association of IGT with WHR. This association was even stronger than the association of IGT with body mass index. But the overall prevalence of IGT was higher in their study (15.6% vs. 10.8% in our study). The difference in the prevalence of IGT among the two populations is most likely due to both genetic and environmental factors.

Out of the 195 subjects studied, only six had impaired fasting glucose (five in group A and one in group B). Most of the subjects who had IGT had normal FBS. The occurrence of normal FBS even in the presence of IGT can be multifactorial. Firstly, FBS depends on the caloric content of the last night's meal, the physical activity following it and the time interval for which the person remains fasting. Secondly, fasting hyperglycemia is proposed to be indicative of a more advanced stage of altered glucose metabolism. This concept was supported by Sinha R and colleagues[9] in their study in which they found that only a small percentage of subjects with IGT had IFG as well.

Significantly higher values of mean FBS and mean post glucose challenge RBS were also observed in the centrally obese individuals. This might suggest that the glucose metabolism of obese persons has a tendency to transform into IGT or diabetes mellitus. Hence more frequent surveillance of blood sugar levels may be recommended for individuals with above normal WHR. This may result in early detection of altered glucose metabolism at the stage of IGT or pre-diabetes where simple interventions like weight loss and lifestyle modification might prevent the development of diabetes mellitus. A number of local and international studies have shown that changes in lifestyle, like weight reduction, dietary modification, and increasing the level of physical activity, may actually reduce the risk of diabetes in obese people.[14,19] After a six years cohort study Tuomilehto J and collegues[14] reported a 58% reduction in the risk of diabetes mellitus by lifestyle modification in subjects with IGT. Since people with abnormally high WHR are more likely to be glucose intolerant, they should be the prime targets of such interventions.

CONCLUSION

The results of this study reinforce the need to encourage the use of waist-to-hip ratio as a screening tool for impaired glucose tolerance and diabetes risk. Determining the WHR is a very easy and cost effective way to identify high-risk obese individuals and can be of value to identify individuals suitable for early institution of preventive measures.

Conflict of Interest: The study has no conflict of interest to declare by any author.

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