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Duration of onset of NIDDM and central obesity in males of Malwa region of Punjab

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ABSTRACT

The present study aims at exploring the correlation of various anthropometric measures with duration of onset of NIDDM and also to find out the correlation of central obesity with BMI. This cross-sectional study was conducted on 140 diabetic males of Malwa region of Punjab. Height, weight, waist circumference (WC) and hip circumference (HC) were taken for assessment of obesity on each participant. Body Mass Index (BMI) and Waist-Hip-Ratio (WHR) were calculated.

The prevalence of overweight and obesity according to BMI was 29.3% and 51.4% of the present sample, respectively whereas the prevalence of abdominal obesity according to the WC and WHR was 77.1% and 92.8%, respectively. The WC showed a strong correlation with BMI and WHR in both obese and non-obese subjects whereas HC showed a strong relationship with only BMI. There was significant association of hip circumference with diabetes, overweight and obesity. As the duration of onset of diabetes increased, there was an increase in BMI, WC, HC and WHR in the males of Malwa region.

Keywords: Body Mass Index, Waist Circumference, Waist-to-hip ratio, obesity, type 2 diabetes, duration of diabetes

INTRODUCTION

Non-insulin dependent diabetes mellitus (NIDDM) is one of the most common chronic diseases and is considered the epidemic of 21st century affecting 382 million people worldwide. India leads the world with largest number of diabetic subjects earning the dubious distinction of being termed the "diabetes capital of the world" (Mohan *et al.,* 2007). In India, 65.1 million people were found to be affected by NIDDM in 2013 and would increase to 109 million by 2035 (IDF, 2013). The key contributors to the rising prevalence of NIDDM throughout the world are the increase in prevalence of obesity, increased urbanization and sedentary lifestyle (Flegal *et al.,* 2002; Pinkney, 2002). Obesity is now recognized as a major risk factor for T2D, hypertension, dyslipidemia and CVD across various populations worldwide (WHO, 2006; Kamath *et al.,* 2011; Hajian-Tilaki and Heidari, 2015).

Simple anthropometric measurements have been used as surrogate measurements of obesity and have more practical value in both clinical practice and for epidemiological studies (Bertin *et al.,* 2000; Field *et al.,* 2001; Dalton *et al.,* 2003). The clinical evidence showed that association of NIDDM with central obesity is stronger than the association with general fat (Azizi *et al.,* 2002; Vazquez *et al.,* 2007; Qiao and Nyamdorj, 2010). Waist Circumference (WC) and Waist-to-Hip ratio (WHR) have been used as measures of central obesity and Body Mass Index (BMI) as general obesity. The central obesity is more important in the Indian population because of the Asian Indian phenotype as shown in the studies (Daousi *et al.,* 2006; Kumar *et al.,* 2008). Excess intra-abdominal fat is associated with greater risk of obesity-related morbidity than is overall adiposity (Ho *et al.,* 2001; Visscher *et al.,* 2002). Thus, measurements of waist circumference and WHR have been viewed as alternatives to BMI.

The epidemiological association between obesity and development of NIDDM have been established in many studies (Snijder *et al.,* 2003; Wang *et al.,* 2005; Vazquez *et al.,* 2007) but a little attention has been paid to the significance of obesity in populations with NIDDM. Thus, the objective of the study was to study the association of anthropometric measures with the duration of NIDDM and to compare body mass index (BMI), waist circumference (WC) and waist-to-hip ratio (WHR) as indices of obesity and assess the respective associations in males with non-insulin dependent diabetes mellitus.

MATERIAL AND METHODS

This study was conducted on 140 male NIDDM patients from Malwa region of Punjab ranging in age from 30-60 years. A written consent was obtained from the subjects after explaining the objectives of the study. The study was approved by the Institutional Ethical Committee of Punjabi University, Patiala. The subjects who had been diagnosed with diabetes since last three years were included in the study based on the clinical records available. The study participants were taking different oral drugs for glycemic control but the dosage was same. The subjects were vegetarian and following a diet that had low trans-fat and glycemic load but with high fiber content.

Four anthropometric measurements (height, weight, waist circumference, hip circumference) were taken on each subject using standard anthropometric methodology (Weiner and Lourie, 1981). Height was measured in a standing position, without shoes with an anthropometric rod and weight was measured with each subject wearing light clothing using a weighing scale. Height (cm) and weight (kilogram) were measured to the nearest 0.1 cm and 0.5 kg, respectively. Waist circumference was measured at the midpoint between the inferior margin of the last rib and the top of the iliac crest. Hip circumference was measured at the largest posterior extension of the buttocks. Waist and hip circumferences were measured to the nearest 0.1 cm using a steel tape. The body mass index (BMI) was calculated using the formula:

$$BMI = \frac{weight\ (kg)}{height^2\ (m)^2}$$

The waist-to-hip-ratio was calculated using the following formula:

$$WHR = \frac{Waist\ circumference\ (cm)}{Hip\ circumference\ (cm)}$$

Obesity was assessed according to the classification of BMI given by WHO (2000). The assessment of abdominal obesity among males was done using the criteria for WC and WHR as given by Snehalatha *et al.* (2003) according to which the subjects having WC ≥85 cm and WHR ≥ 0.88 were abdominally obese.

BMI	Category
<18.5 kg/m^2	Underweight
18.5-22.9 kg/m^2	Normal
23-24.9 kg/m^2	Overweight
25-29.9 kg/m^2	Obese Class I
>30 kg/m^2	Obese Class II

Statistical Analysis

Data analysis was done using the Statistical Package for Social Sciences (SPSS) for Windows version 16. The mean values of the BMI, WC, HC and WHR were determined. To compare the mean differences across different groups based on years of onset of NIDDM, one way ANOVA was performed. To assess the differences between mean values in the obese and non-obese subjects, t-test was applied. The Pearson correlation coefficient was applied for the assessment of relationship between the measures of obesity.

RESULTS

The baseline characteristics of the study participants are presented in **Table 1**. The study sample was divided into four groups on the basis of years of onset of diabetes: (i) 0-5 years (ii) 6-10 years (iii) 11-15 years (iv) 16-20 years. The F-test statistic revealed that there were statistically significant differences ($p<0.05$) between the years of onset of NIDDM with respect to hip circumference. The mean plot of BMI showed that there was an increase during the first decade of the disease but a sharp decrease towards the end of second decade (Fig 1A) and the WHR showed that it increased as the duration of NIDDM increased (Fig 1B).

The percentage of diabetics with general obesity was 51.4%, while 77.1% according to WC and 92.8% according to WHR had central obesity. The distribution of subjects based on duration of onset of NIDDM to assess the nutritional status is shown in **Table 2**. There was high degree of overweight and obesity among all the groups. The rate of under-nutrition was quite low. The chi square analysis revealed that there was statistically significant difference in the rates of overweight and obesity ($\chi^2 = 8.17$, $p<0.05$).

The mean waist circumference (84.21 vs 93.36), hip circumference (90.71 vs 97.02) and waist-hip-ratio (WHR) (0.93 vs 0.96) were significantly higher among the obese than the non-obese

Table 1. Baseline characteristic of the Study Participants.

Characteristic	0-5 years	10-15 years	11-15 years	16-20 years	ANOVA F
Age (years)	50.92±5.80	51.86±3.83	53.23±3.41	54.11±4.51	1.72
Weight (kg)	69.01±9.61	71.67±10.22	74.76±10.61	65.38±5.72	2.36
Height (cm)	165.34±6.12	166.56±6.15	168.38±7.53	166.18±4.43	1.01
WC (cm)	91.10±7.43	92.20±7.68	93.93±6.95	88.56±6.68	1.14
HC(cm)	94.55±5.59	97.32±7.47	97.81±6.24	92.03±3.53	3.35*
BMI (kg/m^2)	25.21±2.82	25.83±3.43	26.28±2.49	23.66±1.68	1.84
WHR	0.96±0.05	0.94±0.05	0.96±0.05	0.96±0.06	0.82

*represents statistically significant at $p<0.05$.

Table 2. Percentage prevalence of BMI based nutritional status in diabetic subjects on the basis of years of onset of diabetes.

BMI	0-5 years	6-10 years	11-15 years	16-20 years	χ^2	p
>18.5	0%	1.9%	0%	0%	8.17*	0.04
18.5-22.9	19.4%	19.6%	7.7%	22.2%		
23.0-24.9	26.9%	27.6%	23.1%	66.7%		
≥25	53.7%	50.9%	69.2%	11.1%		

χ^2 is calculated between overweight-obese.

Df= 3

Table 3. Comparison of circumferences (hip and waist) and WHR in obese and non-obese males (using BMI cutoff point 23 kg/m^2).

	Non-obese	Obese	t-test
Number of subjects	**27**	**113**	
HC	90.17±4.54	97.02±6.17	2.73*
WC	84.21±5.24	93.36±6.80	6.63**
WHR	0.93±0.05	0.96±0.05	5.44**

*represents statistically significant at $p<0.05$ and ** represents significance at $p<0.01$.

Table 4. Correlation between derived and basic anthropometric indices in subjects with Type 2 Diabetes mellitus.

	BMI (kg/m^2)		**WHR**	
	Non-obese	**Obese**	**Non-obese**	**Obese**
WC	0.63*	0.71**	0.66*	0.68*
HC	0.54*	0.74**	-0.23	-0.35

** statistically significant at 0.01 level
* statistically significant at 0.05 level

Table 5. Partial correlation coefficients (age-controlled) between the anthropometric variables among the diabetic subjects with duration of disease 0-5 years and 6-10 years

Variables	**Weight (kg)**	**Height (cm)**	**Waist Circumference (cm)**	**Hip Circumference (cm)**	**BMI (kg/m^2)**	**WHR**
Weight (kg)	1	**0.59***	**0.76****	**0.88****	**0.85****	**0.19**
Height (cm)	0.38	1	**0.29**	**0.45**	**0.08**	**-0.05**
WC (cm)	0.79*	0.38	1	**0.74****	**0.76****	**0.69****
HC (cm)	0.82**	0.29	0.76**	1	**0.79****	**0.02**
BMI (kg/m^2)	0.86**	-0.14	0.78**	0.71**	1	**0.27**
WHR	0.08	-0.26	0.47*	-0.21	0.23	1

* represents statistically significant at $p<0.05$
** represents statistically significant at $p<0.01$
0-5 years duration of disease= above diagonal in bold
6-10 years duration of disease = below diagonal

patients, respectively (**Table 3**). This trend indicated that there is an increased level of intra-abdominal fat in the obese individuals as compared to non-obese. Among both obese and non-obese, there was significant correlation between the WC and BMI; WC and WHR. There was

significant correlation between HC and BMI in obese and non-obese subjects; however, the HC correlated poorly with WHR in non-obese and obese (**Table 4**).

There was significant partial correlation after controlling for age between the anthropometric variables among the groups with different duration of disease. There was highly significant correlation between the variables in first decade of the NIDDM ($p<0.01$) (**Table 5**). But there was modest correlation found towards the end of the second decade of disease ($p<0.05$) (**Table 6**).

Table 6. Partial correlation coefficients (age-controlled) between the anthropometric variables among the diabetic subjects with duration of disease 11-15 years and 16-20 years

Variables	**Weight (kg)**	**Height (cm)**	**Waist Circumference (cm)**	**Hip Circumference (cm)**	**BMI (kg/m^2)**	**WHR**
Weight (kg)	1	**0.75****	**0.77****	**0.90****	**0.78****	**-0.03**
Height (cm)	0.60	1	**0.32**	**0.66***	**0.17**	**-0.39**
WC (cm)	0.67	0.14	1	**0.77****	**0.84****	**0.52**
HC (cm)	0.41	0.12	0.37	1	**0.69***	**-0.14**
BMI (kg/m^2)	0.78*	-0.02	0.73*	0.42	1	**0.35**
WHR	0.48	0.09	0.85**	-0.18	0.53	1

* represents statistically significant at $p<0.05$
** represents statistically significant at $p<0.01$
11-15 years duration of disease= above diagonal in bold
16-20 years duration of disease= below diagonal

DISCUSSION

The results of the present study show that mean BMI was above the normal range in all the groups which is an important risk factor for non-insulin dependent diabetes (Heshka *et al.*, 2008). Majority of the subjects were obese and this clearly brings out that obesity is a very common problem in type 2 diabetes cases. The similar association between obesity and NIDDM have been shown in earlier studies (Daousi *et al.*, 2006; Kumar *et al.*, 2008; Kumar, 2013).

In the present study it was found that WC had a strong correlation with BMI and WHR in both obese and non-obese NIDDM subjects. Adediran *et al.* (2007) also found a strong correlation between BMI and WC, and WC and WHR in diabetic subjects with and without metabolic

syndrome. Central obesity, which develops much earlier in Asian population, is therefore a stronger predictor of NIDDM.

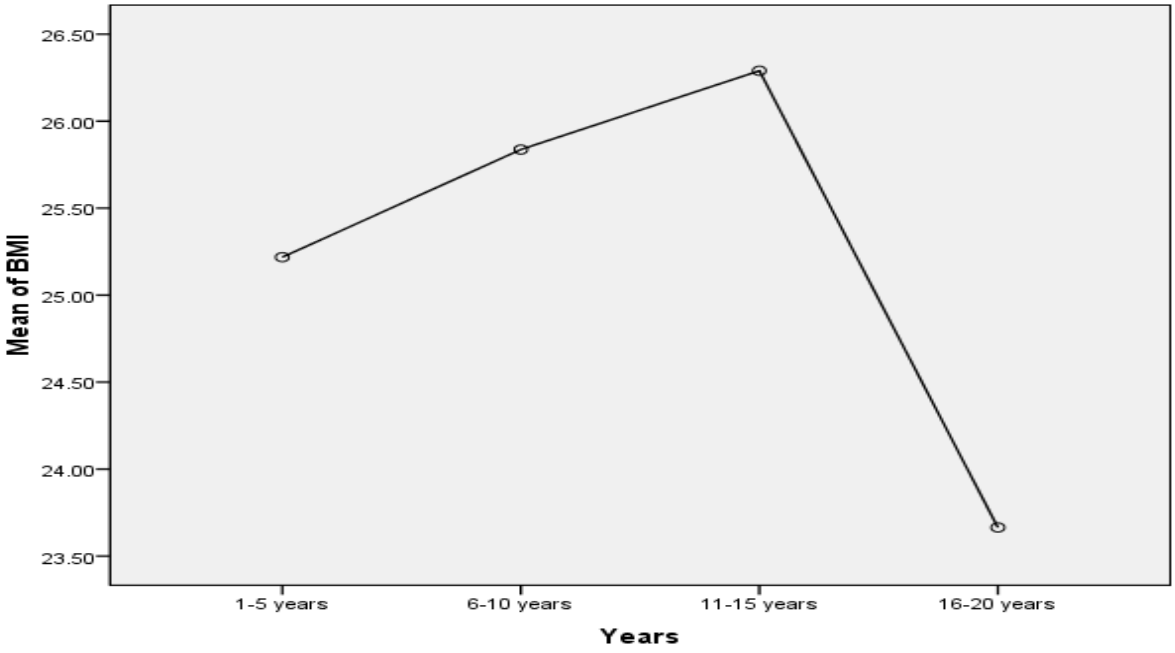

Figure 1A

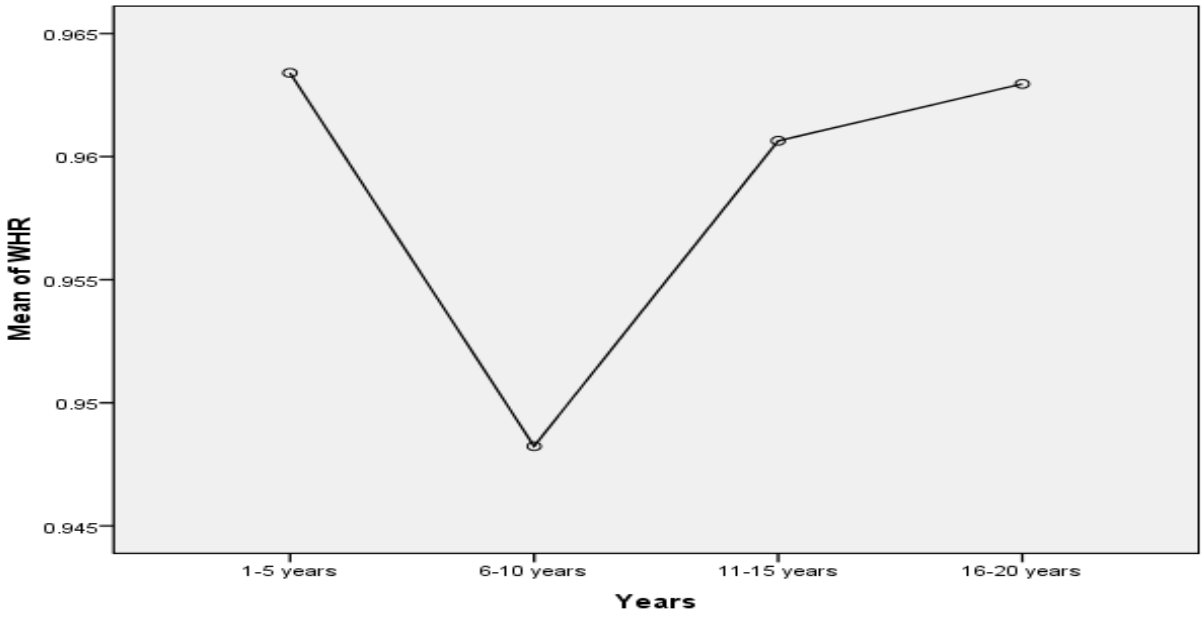

Figure 1B

Figure 1(A and B): Mean plot of BMI and Waist-to-Hip Ratio (WHR) with respect to years of onset of diabetes.

The distribution of BMI across the four groups of years of onset showed that there were statistically significant differences in overweight and obese among the studied population. The study by Akter *et al.* (2014) also showed similar results by multivariate analysis that duration of diabetes correlate with overweight and central obesity.

In the Hoorn Study (Snijder *et al.,* 2003) where the contribution of thigh circumference and hip circumference to measures of glucose metabolism independent of waist circumference was investigated; it was found out that thigh circumference in women and hip circumference in both sexes are negatively associated with markers of glucose metabolism independently of the waist circumference whereas a larger waist circumference is associated with a higher risk. Lissner *et al.* (2003) showed that smaller hip circumferences predicted the incidence of self-reported diabetes in women in a prospective study. The results of the present study are consistent with these findings as hip circumference was significantly associated with duration of onset of diabetes.

The anthropometric parameters correlated significantly with the duration of NIDDM as there was stronger association during the first decade of the disease which decreased to modest in the second decade. Similar results were found in a study by Dambal *et al.* (2011) in which there was positive correlation between WHR and duration of NIDDM.

The present study has a limitation as it is restricted only to male NIDDM patients of Malwa region. Further longitudinal studies considering other regions and females are necessary for effective prevention and management of obesity in patients with NIDDM.

Thus, as the duration of NIDDM increases, the anthropometric parameters also increase along with increase in risk for cardiovascular diseases.

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