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EVALUATE THE CORRELATION & COMPARISON BETWEEN BODY MASS INDEX AND WITH THE INCREASING RISK OF TYPE II DIABETES MELLITUS AND NON DIABETIC POPULATION

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Abstract

Body Mass Index (BMI) is an association between the degree of obesity, body fat distribution and weight gain with subsequent consequence of Type II diabetes mellitus have been determined. BMI are now well established independent risk factors for the development of Type II diabetes. The present study aims to evaluate the association of BMI with increasing risk of Type II DM and differentiation between BMI of Type II DM and healthy subjects**.**The consent from the study subjects was taken before enrolling in the study. This is a case control study and total subjects was 200 which is further divided into 100 cases and 100 controls were included in the study. According to anthropometric parameters between cases and controls there was statistically significant ($p<0.0001$) in weight & BMI but the difference of height is statistically not significant. Moreover, the mean BMI range was found to be significantly ($p<0.0001$) higher difference in cases than controls in all the age groups. In view of study outcome, we concludedthat diabetes has a positive association with age, weight and BMI and BMI is found to be significantly higher in cases than controls.

Keywords: Body Mass Index, Diabetes Mellitus, Fasting Blood Sugar, Non-Insulin-Dependent Diabetes Mellitus, Positive Predictive Value.

Introduction

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion and insulin action or both. The chronic hyperglycemia is associated with long-term damage, dysfunction, and failure of normal functioning of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels (American Diabetes Association, 2012). The Quetlet's Index or Body Mass Index (BMI) is the most frequently used indicator of total body adiposity in epidemiological studies (Aruna et al, 2002). BMI and both waist to hip ratio (WHR) and waist circumference (WC) are now well-established independent risk factors for the development of Type II diabetes and has been shown to have a direct association with overall mortality in both men and women (Bertin et al, 2000; Boden, 1997). A WHO expert consultation addressed the debate about interpretation of recommended body mass index (BMI) cut-off points for determining over-weight and obesity in Asian populations, and considered whether population-specific cut-off points for BMI are necessary. They came to an opinion that the proportion of Asian people with a high risk of Type II diabetes and cardio-vascular disease is substantial at BMIs lower than the existing WHO cut-off points for over-weight (≥ 25 kg/m^2) (WHO,2004). In addition, studies that have analyzed the association of anthropometric measures and abdominal visceral fat have found waist circumference to be a better measure of central obesity because it is a better predictor of abdominal visceral fat obtained with computed tomography than is waist/hip ratio, and it can be easily measured and interpreted (Jensen, 2006). However, waist circumference cannot distinguish abdominal subcutaneous fat, total abdominal fat, and total body fat, and it is strongly correlated with body mass index. Body mass index has been shown to be a good indicator of general fatness (fat areas in the arm, thigh, and waist using computed tomography scans), muscularity (muscle area in the thigh), and frame size (bone area in thighs) (Seidell et al, 1989).

Literature Review

Diabetes is a major source of morbidity, mortality, and economic cost to the society. People with diabetes showed the risk of the development of acute metabolic complications such as diabetic ketoacidosis, hyperglycaemic, hyperosmolar nonketotic coma, and hypoglycaemia (English and Williams, 2004). In addition to this, diabetics are also at risk of experiencing chronic complications such as coronary heart diseases, retinopathy, nephropathy and neuropathy, and foot ulceration. A variety of factors influence the development of diabetic pathologies. Insulin resistance which develops from obesity and physical inactivity acts as substrate for genetic susceptibility (DeFronzo and Ferrannini, 1991). Since food intake influences the amount of insulin required to meet blood glucose target goals, the food especially carbohydrate intake could contribute to the pathology of diabetes. Dietary carbohydrate influences postprandial blood glucose levels the most and is the major determinant of meal-related insulin requirements. The intermediate- or longer-acting insulin usually covers the effects of protein and fat. It has been shown that low carbohydrate ketogenic diet is effective in the amelioration of many of the deleterious consequences of diabetes. It has been observed that insulin secretion declines with advancing age, and this decline may be accelerated by genetic factors. Insulin resistance typically precedes the onset of

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type 2 diabetes and is commonly accompanied by other cardiovascular risk factors: dyslipidemia, hypertension, and prothrombotic factors (Al-Khalifa et al, 2011).

It has been estimated that expenditure of diabetic persons on health is about four folds higher than that of general healthy population. The prospective studies have provided unequivocal evidence on crucial role of prolonged hyperglycaemia in the development of chronic diabetic complications (Paneni et al, 2013; Jaganjac et al, 2013).

Types of diabetes mellitus

Diabetes mellitus can be classified in different ways but one form of classification is as follow (American Diabetes Association, 2004)-

1. Type I diabetes (Insulin dependent) is due to immune mediated beta-cells destruction, leading to insulin deficiency.
2. Idiopathic diabetes is the type 1 diabetes with no known etiologies and is strongly inherited.
3. Type II diabetes (Non-Insulin dependent) is due to insulin secretory defect and insulin resistance.
4. Gestational diabetes mellitus is any form of intolerance to glucose with onset or first recognition of pregnancy.

However, diabetes is mostly classified basically into TWO major types: Type I Diabetes (IDDM) and Type II Diabetes (NIDDM).

Type 1 diabetes occurs as a result of auto-immune beta-cell destruction in the pancreas, characterized by a total absence of insulin production. Type 1 diabetes is responsible for 5% to 10% of all cases of diabetes. Associated risk factors include autoimmune, genetic, and environmental factors. Until the present time, known solutions to prevent diabetes have not been discovered (Deshpande, 2008).

In type 1 diabetes, also referred to as insulin-dependent diabetes mellitus (IDDM) or as juvenile onset is relatively early in life, in childhood or adolescence and usually before the age of thirty. This type of diabetes is a relatively homogeneous disease in which the insulin secretion of beta cells in the pancreas declines and eventually ceases totally (Aalto, 1999).

Type 2 diabetes can be linked to be accounting for around 90 per cent of all cases, it is a chronic metabolic disorder, in which the body is unable utilize glucose from food because of the inability of the pancreas to produce insulin or produces insufficient insulin, or the insulin itself is inactive (Naemiratch and Manderson, 2007). Type 2 develops when there is an unexpected increased resistance against the action of insulin and the body cannot produce proportionate insulin to counter the resistance. The incidence of Type 2 diabetes in children and adolescents is noted to be on a dramatic increase. It accounts for 90% to 95% of all diagnosed cases of diabetes (Deshpande, 2008). Many societies in this present society view overweight individuals from an unfavourable angle. This could be linked to the belief that obese individuals cannot impact self-control on themselves and have lower intelligence (Debono and Cachia, 2007).

The global epidemic of type 2 diabetes mellitus grossly affects indigenous and developing populations. Although genotypic variants related to energy balance may be responsible for the epidemic (Dyck et al, 2010). Type 2 diabetes (T2D) is a metabolic disorder that affect organs in multiples, and its incidence is on the increase at the world level. Over 170 million people and 37 million people in China that are affected by T2D is accounting for 90% of total patients with diabetes. Estimation shows that in 2010, the total number of patients with diabetes will be up by nearly 50%, most especially in the developing countries of Africa, Asia, and South America. Although the pathogenesis of T2D is still obscure but the available medical treatments, together with controlled diet and exercise, have proven to be effective in controlling hyperglycemia and prolong patients' lifespan (Jin et al, 2009).

Gestational diabetes, could be described as a form of glucose intolerance that affects some women during pregnancy. This kind of diabetes is triggered during pregnancy. Most GDM is resolved naturally after delivery, but 5-10 percent of women affected during pregnancy are later found to have diabetes, especially Type 2, after pregnancy. Furthermore, women who have had history of gestational diabetes have a 40-60 percent chance of developing diabetes in the following 10 years. Therefore, changes in lifestyle implemented to normalize blood glucose during pregnancy become essential preventive measures against development of Type 2 diabetes. Pre-diabetes affect 54 million adults and this places them at risk of developing diabetes later in the nearest future (Renosky et al, 2008).

There are other groups of types of diabetes caused by specific genetic defects of beta-cell function or insulin secretion, diseases of the pancreas drugs or chemicals (Deshpande, 2008).

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Methodology

This case control study was conducted in the Department of Anatomy and Medicine, IIMS & R, Integral University, Lucknow. The diabetes mellitus (type II) were selected as test group and 100 control group from healthy population residing in Lucknow.

The Ethical Clearance was obtained from the Institutional Ethical Committee.

Blood sugar criteria for diagnosis: FBS: >=126mg/dl. PP sugar >=200mg/dl 2 hrs. after meal RBS >=200mg/dl and HBA1C >=7 unit.

- **MODY:** is a rare form of diabetes which is different from both Type 1 and Type 2 diabetes, and runs strongly in families. **MODY** is caused by a mutation (or change) in a single gene. If a parent has this gene mutation, any child they have, has a 50% chance of inheriting it from them.
- **Lada-**Latent autoimmune diabetes in adults (**LADA**) is a slow progressing form of autoimmune diabetes. Like type 1 diabetes, **LADA** occurs because the pancreas stops producing adequate insulin, most likely from some "insult" that slowly damages the insulin-producing cells in the pancreas. It is a kind of type 1 diabetes in adult. It occurs normally in 25-30 age group.
- Secondary form of diabetes such as pancreatic tumours, pseudocysts, Cancers etc.
- Diabetes originating from drugs such as thyroid hormones, steroids, contraceptives, Thiazides etc.

BMI of each subject were calculated.

Statistical analysis

The results are presented in mean±SD. Chi-square test were used to compare the categorical variables between cases and controls. The Unpaired t-test were used to compare BMI and blood sugar between cases and controls. The Pearson correlation coefficient was calculated. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) with accuracy were calculated. The receiving operating curve (ROC) analysis was carried out. The area under the curve (AUC) with its 95% confidence interval (CI) was calculated. The p-value<0.05 were considered significant.

Results

The present study was conducted in the Department of Anatomy and Medicine, IIMS & R, Integral University, Lucknow, with the objective to determine the BMI ranges in type II diabetic subjects and comparison of BMI in cases and controls. A total of 100 cases and 100 controls were included in the study. The following data were evaluated in this research-

[1]. The mean age of cases and controls was 53.62±10.19 and 48.76±10.87 years respectively. There was no significant (p>0.05) difference in the age between cases and controls. Table-1 & Fig. 1 shows the age distribution of cases and controls.

Age in years	Cases (n=100)		Controls (n=100)		p-value[1]
	No.	%	No.	%	
<40	12	12.0	25	25.0	0.06
41-50	24	24.0	36	36.0	
51-60	38	38.0	19	19.0	
>60	26	26.0	20	20.0	
Mean±SD	53.62±10.19		48.76±10.87		

[1]Chi-square test

Table-1: Age distribution of cases and controls

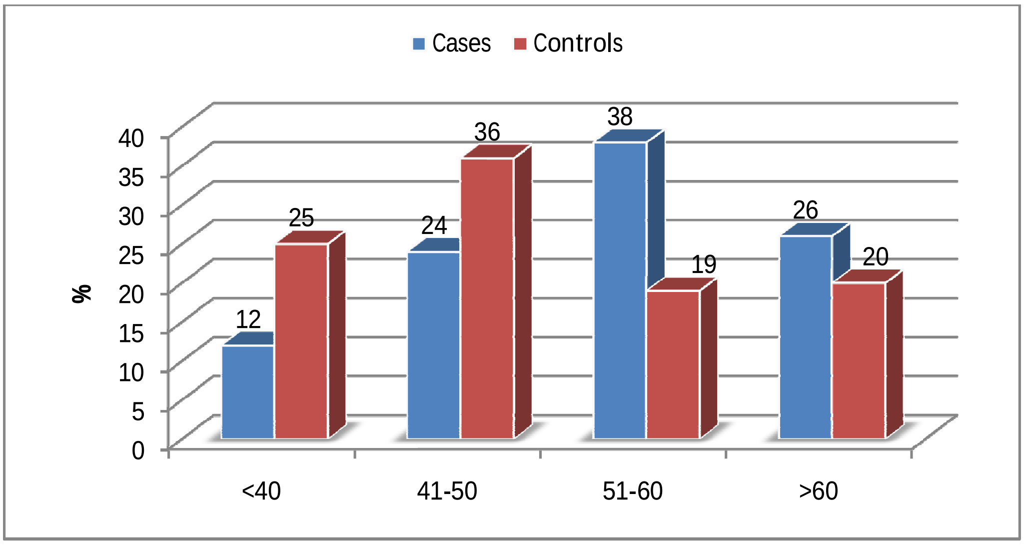

Fig. 1: Age distribution of cases and controls

[2]. The mean height of cases and controls was 160.97±6.48 and 162.53±7.86 respectively, however, the difference statistically not significant (p>0.05). There was significant (p=0.0001) difference in weight and BMI between the groups. Table-2 & Fig. 2 shows the comparison of anthropometric parameters between cases and controls.

	Cases	Controls	p-value[1]
Height in cms	160.97±6.48	162.53±7.86	0.12
Weight in kgs	69.78±6.04	62.13±6.31	0.0001*
BMI in kg/mtr^2	26.91±1.57	23.53±1.94	0.0001*

[1]Unpaired t-test,*Significant

Table-2: Comparison of anthropometric parameters between cases and controls

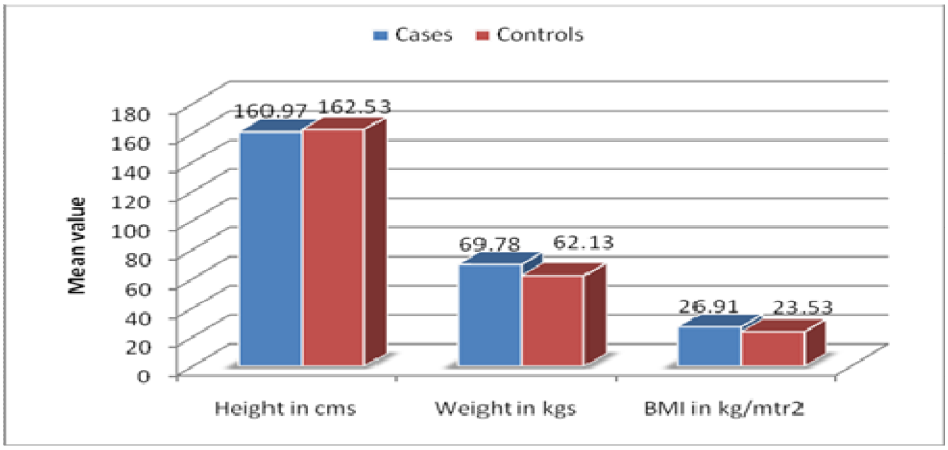

Fig. 2: Comparison of anthropometric parameters between cases and controls

[3]. Table-3 & Fig. 3 shows the comparison of BMI category between cases and controls. The percentage of overweight was higher among the cases (93%) than controls (12%). However, the percentage of normal was found to be lower in cases (3%) than controls (88%). There was no significant (p>0.05) difference in the BMI category between cases and controls.

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	Cases (n=100)		Controls (n=100)		p-value[1]
	No.	%	No.	%	
Normal (18.5-24.9)	3	3.0	88	88.0	0.57
Overweight (25-29.9)	92	93.0	12	12.0	
Obese I (30-34.9)	4	4.0	0	0.0	

[1]Chi-square test

Table-3: Comparison of BMI category between cases and controls

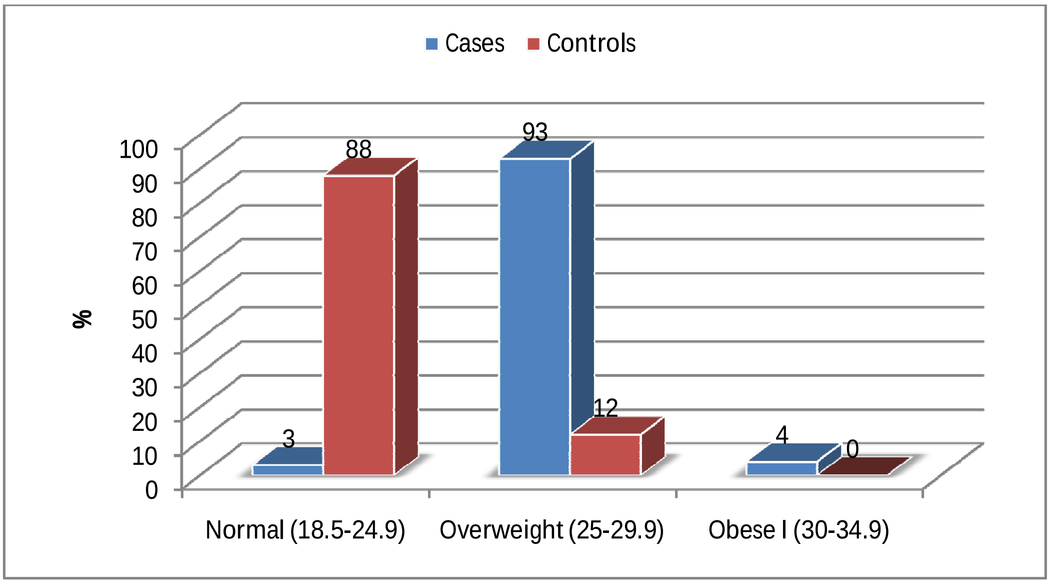

Fig. 3: Comparison of BMI category between cases and controls

[4]. Table-4 & Fig. 4 shows the comparison of BMI between cases and controls according to age groups. The mean BMI was found to be significantly (p=0.0001) higher in cases than controls in all the age groups.

Age in years	Cases	Controls	p-value[1]
<40	26.46±1.55	23.10±1.52	0.0001*
41-50	26.85±1.62	22.93±1.90	0.0001*
51-60	27.33±1.79	23.93±1.82	0.0001*
>60	26.57±1.01	24.79±1.95	0.0001*

[1]Unpaired t-test, *Significant

Table-4: Comparison of BMI between cases and controls according to age groups

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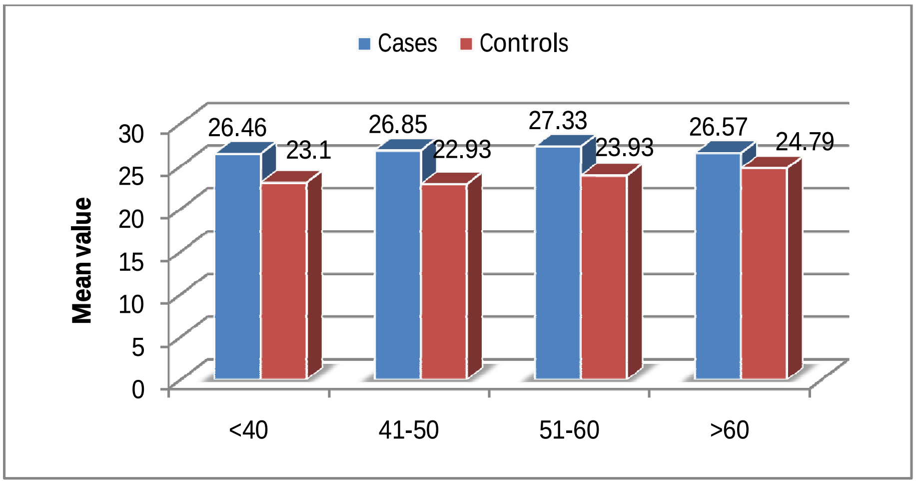

Fig. 4: Comparison of BMI between cases and controls according to age groups

[5]. Table-5 & Fig. 5 shows the predictive value of BMI for the diagnosis of NIDDM. The sensitivity and specificity of BMI with cutoff value ≥25.99 was 69% and 91%. PPV and NPV was 88.5% and 74.6% with accuracy being 80%.

	BMI≥25.99
Sensitivity	69.0
Specificity	91.0
Positive predictive value (PPV)	88.5
Negative predictive value (NPV)	74.6
Accuracy	80.0
AUC (95%CI), p-value	0.92 (0.88-0.96), 0.0001*

*Significant

Table-5: Predictive values of BMI for NIDDM

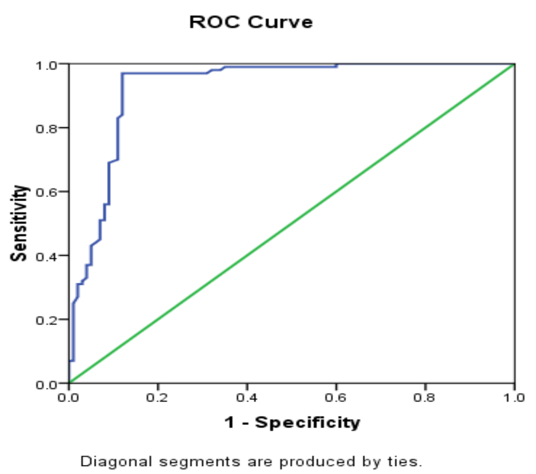

Fig.6: ROC curve showing sensitivity and specificity of BMI for NIDDM

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Discussion

Obesity has been recognized as a major health problem, in the past two to three decades. Obesity, especially central obesity, is an important risk factor for the high prevalence of type II diabetes mellitus. "Diabetes Mellitus", is a chronic disease which requires long standing medical attention, is a leading cause of death in the developing countries. WHO estimates that by 2010 there will be nearly 221 million diabetics all over the world (Anita et al, 2016).

Type II diabetes is the most common type of diabetes, and is usually associated with obesity. It usually develops after the age of 40 and is not associated with total loss of ability to secrete insulin. Type II diabetes was once called adult-onset diabetes. Now, because of the"epidemic" of obesity and inactivity in children, type II diabetes is occurring at younger ages. It is characterized by impaired insulin secretion, with progression towards insulin deficiency and insulin resistance.

The association between degree of obesity, body fats distribution and weight gain with subsequent occurrence of Type II diabetes has been examined in several prospective studies. Increased BMI is now a well-established independent risk factor for the development of Type II diabetes (Boden, 1997; Bertin et al, 2000).

The present study was conducted in the Department of Anatomy and Medicine, IIMS & R, Integral University, Lucknow with the objective to determine the correlation between BMI ranges in type II diabetic subjects and comparison of BMI ranges in cases and controls. A total of 100 cases and 100 controls were included in the study. More than one third of cases (38%) and 19% of controls were in the age group 51-60 years. The mean age of cases and controls was 53.62±10.19 and 48.76±10.87 years respectively. There was no significant ($p>0.05$) difference in the age between cases and controls.

In the present study, body mass index (BMI) of the cases was found to higher than control subjects. BMI was 26.91±1.57 in cases and 23.53±1.94 in the controls. BMI was found to be in borderline of obesity in cases and within normal range as per WHO recommendations (WHO, 2000).

BMI was described as the strongest predictor of type II diabetes. It is clear from the present study that BMI increases with age and BMI of case and controls was positively correlated with age. An Indian study showed that diabetes has a positive and independent association with age and BMI (Ramachandran et al, 2001).

The diabetics were not classified separately by their types, so it is not possible to comment about relation between obesity and type II diabetes specifically. But obesity is mostly related to Type II diabetes (Aruna et al, 2002; Boden, 1997; Guyton and Hall, 2003). Obesity, in particular abdominal or central obesity, is closely linked with insulin resistance. Among obese individuals, enhanced lipolysis and release of free fatty acids inhibits insulin stimulated peripheral glucose uptake in dose dependent manner while simultaneously inhibiting insulin secretion (Boden, 1997).

The risk of developing type II diabetes and cardiovascular diseases is high at relatively low BMI values in subjects who is originating from South East Asian countries and as compared to white population (Moon et al, 2002; Ito et al, 2003). Other studies from northern parts of India had also shown that the normal BMI for an Indian was < 22 kg/m^2 (Singh et al, 1992; Dudeja et al, 2001). The relationship of Diabetes and impaired glucose tolerance (IGT) for BMI value of >22 kg/m^2 had been established in Asian countries (Akanuma, 1996; Zhou, 2002). So, it is likely that the South Asian people have BMI cut-off value lower than Westerners. BMI might not correspond to the same body fat in different populations because of variations in body proportions, which can be the reason for lower BMI in Asians (King et al, 1998). It has been observed that normal cut-off value for BMI in Asian Indian adults is <23 kg/m^2 (Snehalatha et al, 2003).

In 2002 WHO expert consultation was made to recommend body mass index (BMI) cut-off points for determining over-weight and obesity in Asians populations. They noted that the number of Asians with a high risk of Type II diabetes and cardiovascular disease is substantial at BMIs lower than 25 kg/m^2. The cut-off points for observed risk varies from 22 kg/m^2 to 25 kg/m^2 in different Asian populations and for high risk it varies from 26 kg/m^2 to 31 kg/m^2. WHO consultation proposed that further study is required in different Asian countries to find out BMI cut-offs to assess potential risk in overweight population for diabetes and cardiovascular diseases (WHO, 2004).

In the present study, the sensitivity and specificity of BMI with cutoff value ≥25.99 was 69% and 91%. PPV and NPV was 88.5% and 74.6% with accuracy being 80%. In a study (Ali et al, 2009), for the definition of overweight, ROC curve analysis suggested optimal BMI cut-offs of 28.50 to 29.50 in men and 30.50 to 31.50 in women, but the levels of sensitivity and specificity

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were too low to be of clinical value and the overall misclassification was unacceptably high across all the selected BMI values (>0.80). In another study (Rosana et al, 2007)), for different BMIs, sensitivity and specificity for percentiles 25, 50, 75, 90 and 95 were obtained. Increased odds ratios for diabetes mellitus and hypertension were observed with BMI values $\geq$ 25kg/m^2. The 50th percentile corresponded to the highest sensitivity and specificity for the identification of risk for both diseases.

Conclusion

In the present study, it is clear that BMI is the strongest predictor of type II diabetes and it increases with age and overweight because BMI of the cases was found to be significantly (p=0.0001) higher than control and positively correlated with age and overweight, the difference of height is statistically not significant.

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