Prevalence of Diabetes and Pre-diabetes in Class III and Class IV Healthy Obese Employees of KIMS University, Maharashtra

Anjum K. Sayyed*, Dr. Vilas U. Chavan, Dr. Nazir R. Attar ***, Dr. Satish Kakade****, Dr. Sangita R. Patil*, Dr. Ajit V. Sontakke***

* Department of Biochemistry, KIMS, Karad, Maharashtra, **Department of Biochemistry, SMIMER, Surat, Gujarat, *** Department of Medicine, K.S. Hedge Medical Academy and K.S. Hedge Hospital Deralkatte, Mangalore, Karnataka, **** Department of Community Medicine, KIMS, Karad, Maharashtra, India.

Abstract: Background & objectives: Diabetes is the most common metabolic disorder and its prevalence is increasing in almost all countries. The aim of the study was to estimate the prevalence of undiagnosed diabetes and pre-diabetes in class III and class IV healthy obese employees of Krishna Institute of Medical Sciences (KIMS) University, Karad, Maharashtra. Methods: We screened 600 employees of KIMS University, out of these 105 were included in this study. We studied oral glucose tolerance test (OGGT) and glycosylated hemoglobin (HbA1c) in study group. Classification of new cases was based on the oral glucose tolerance test (OGGT). Results: The prevalence of undiagnosed diabetes among class III and class IV healthy obese employees was 3.8 %, where as pre-diabetics 7.6% making total of 11.4%. Oral glucose tolerance test (OGGT) level was significantly higher (P<0.001) in diabetics and pre-diabetics when compared to non-diabetics. Normal or low level of glycosylated hemoglobin (HbA1c) was found in diabetics and pre-diabetics. Conclusion: The findings of our study and their implication would help to design disease prevention and to reduce morbidity in healthy obese individuals. We recommend that screening for the diabetes and pre-diabetes should be employed as part of routine occupational health check-up programme and OGTT may be the gold standard test to identify undiagnosed diabetes and pre-diabetes in healthy obese individuals [Chavan V U et al NJIRM 2011; 2(4) : 39-44]

Key Words: Obesity, Diabetes, Pre-diabetes, Oral glucose tolerance test, Glycosylated hemoglobin

Author for correspondence: Dr. Vilas. U. Chavan, Assistant Professor, Department of Biochemistry, Surat Municipal Institute of Medical Education & Research (SMIMER), Surat, Gujarat, India. E-mail: drvuchavan@yahoo.co.in

Introduction: The prevalence of diabetes is rapidly increasing all over the globe at an alarming rate[1] Over the past 30 years, the status of diabetes has changed from being considered as a mild disorder of the elderly to one of the major causes of morbidity and mortality affecting the youth and middle age people. India leads the world with largest number of diabetic subjects earning the dubious distinction of being termed the "diabetes capital of the world" [2].

Diabetes is the most common metabolic disorder and its prevalence is increasing in almost all countries. The worldwide prevalence of diabetes in adults was estimated to be 4.0% in 1995 and to rise to 5.4% by the year 2025. The number of adults with diabetes in the world will rise from 135 million in 1995 to 300 million in the year 2025. The major part of this numerical increase will occur in developing countries. The countries with the largest number of people with diabetes will be India, China, and the U.S. in the year 2025 [3]. The International Diabetes Federation (IDF) estimates the total number of diabetic subjects to be around 40.9 million in India and this is further set to rise 69.9 million by the year 2025 [4].

The term impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) refer to a metabolic stage intermediate between normal glucose homeostasis and diabetes, referred to as pre-diabetes [5].

Projected increase in the global prevalence of type 2 diabetes suggest that its treatment and prevention could become one of the major health challenges of 21st century and yet large number of cases remain undiagnosed [6]. The increase in type 2 diabetes is related to lifestyle changes that have resulted in overweight, obesity, and decreased physical activity levels [7]. Patients with IFG and /or IGT have risk for future development of diabetes, hypertension and cardiovascular disease [2, 8]. IFG and IGT patients are associated with the obesity

(especially abdominal or visceral obesity) [8]. Individuals with both IFG and IGT have approximately double the rate of developing diabetes compared with individuals with just one of them [7]. Hence data on IGT and IFG are also urgently needed as they are indicators of future diabetes prevalence and burden on the nation[2].
Diabetes is an increasingly prevalent and burdensome disease in working populations [6]. Because of the asymptomatic nature of type 2 diabetes, 33 - 50% of individuals with the disease do not know they have it [9]. The American Diabetes Association (ADA) recommends screening men and women ≥ 45 years for undiagnosed type 2 diabetes[10]. The ADA also recommends early detection and treatment of individuals with pre-diabetes[11].
There fore this study was aimed to find out the prevalence of new (undiagnosed) cases of diabetes and pre-diabetes in working population, class III and class IV healthy obese employees.

Material and Methods: The cross sectional study was conducted from August 2008 to September 2009. We screened 600 class III and class IV employees including nursing staff, attendants, sweepers, technicians and clerks.

This study was approved by Ethical Committee of KIMS University and informed consent was taken from all participants. A team comprising of interns and medical officers were given training in order to collect uniform information from the subjects. Detail history was taken and physical examination was done.

Undiagnosed diabetes: The person is harbouring the disease, but does not know either asymptomatic or not seeked medical advice or not diagnosed earlier.

Pre-diabetes: "Pre-diabetes" is defined as the presence of impaired fasting glucose (IFG) and /or impaired glucose tolerance (IGT) [12, 13]. A single abnormal reading at formal testing is adequate to define pre-diabetes[12]. The terms IGT and IFG refer to a metabolic stage intermediate between normal glucose homeostasis and diabetes, now referred to as pre-diabetes[5]. WHO Criteria[13] for diagnosing pre-diabetes - impaired fasting glucose (IFG) level and impaired glucose tolerance (IGT) is given in Table 1.

Inclusion criteria: Adults aged between 20-50 years, obese individuals with BMI ≥ 25 kg/m^2, non-diabetic, non-hypertensive, not receiving any treatment were included in the study group. This group was called as healthy obese individuals.

Exclusion criteria: Known cases of diabetes, hypertension, dyslipidemia, cardiovascular disease, pregnancy, any major illness (like kidney diseases, metabolic diseases, tuberculosis etc.) or subjects receiving hypolipidemic drugs or thyroid disease affecting glucose or lipid metabolism were excluded.
600 subjects were screened for obesity (body mass index (BMI) of ≥ 25 kg/m^2) according to World Health Organization (WHO) criteria[14]. 105 subjects were found eligible to include in this study.

Oral glucose tolerance test (OGTT) was performed after overnight fast. A second visit was arranged for only those whose fasting (F) or 2-hour post glucose load (2-h OGTT) plasma glucose was higher than the normal. Classification of new cases was based on oral glucose tolerance test (OGTT) according to the WHO criteria[13] as normal, impaired fasting glucose (IFG), impaired glucose tolerance (IGT) and diabetes (Table 1).

Table 1. Diagnostic criteria for diabetes and intermediate hyperglycemia (WHO, 2006) [13]

Condition	Plasma glucose concentration			
	Normal	**Impaired Fasting Glucose (IFG)**	**Impaired Glucose Tolerance (IGT)**	**Diabetes**
Fasting	**< 6.1mmol/l (<110 mg/dl)**	**6.1 to 6.9 mmol/l (110 to 125 mg/dl)**	**< 7.0 mmol/l (< 126 mg/dl)**	**≥ 7.0 mmol/l (≥ 126 mg/dl)**
2-h plasma glucose**	**< 7.8 mmol/l (<140 mg/dl)**	**< 7.8 mmol/l (< 140 mg/dl)**	**≥7.8 and <11.1 mmol/l (≥140 and <200 mg/dl)**	**≥ 11.1 mmol/l (≥ 200 mg/dl)**

****** Venous plasma glucose 2-hour after ingestion of 75 g of oral glucose load.

Individuals with positive findings were referred to medicine department for follow-up and further treatment.

Blood samples: Fasting 2 ml blood was collected in fluoride bulb after overnight fast (8-10 hr). For OGTT 75 gm glucose dissolved in 300 ml of water was given orally to study subjects. The OGTT was done as per WHO protocol[13]. Second venous blood sample was collected again after 2 hours, called as 2–hour post-glucose load [2-h OGGT]. Blood samples were then subjected to estimation of plasma glucose and glycosylated hemoglobin (HbA1c), (collected in EDTA bulb). Glucose estimation was done by glucose oxidase peroxidase method[15], where as HbA1c was determined by cation exchange resin method[16].

Statistical Analysis: Data is expressed as Mean $\pm$ SD. Comparison of study variables between diabetes and others was done by applying unpaired 't' test. The difference was said to be significant when P was < 0.05.

Results: Age distribution of study subjects are shown in the Table 2. There was no significant difference among diabetes and pre-diabetes when compared to normal obese individuals. We observed slightly younger age group (31-41years) more prone to diabetes and pre-diabetes than that of elder healthy obese subjects. All comparison with normal healthy obese individuals was not-significant.

Table 2. Age of the study subjects and their status.

Clinical condition	Subjects (n = 105)	Age (years) Mean ± SD	'P' Values
Normal	**93**	**42.25±8.32**	
Diabetes	**4**	**41.0±6.48**	**0.767**
IGT	**4**	**37.75±6.07**	**0.288**
IFG	**4**	**40.0±5.85**	**0.594**

IGT; Impaired Glucose Tolerance, IFG; Impaired fasting glucose.

Table 3. shows HbA1c levels in the study subjects. The levels of HbA1c in diabetes and pre-diabetes were found to be non-significant when compared to normal obese subjects.

Table 3. HbA1c in the study subjects.

Clinical condition	Subjects (n = 105)	HbA1c Mean ± SD	'P' Values
Normal	**93**	**6.70 ± 1.16**	
Diabetes	**4**	**6.45 ± 1.54**	**0.663**
IGT	**4**	**6.77±1.37**	**0.913**
IFG	**4**	**6.82 ± .92**	**0.846**

All comparison with normal healthy obese individuals was not-significant.

Significant increase in level of fasting plasma glucose (FPG) was observed in diabetes and pre-diabetes as compared to normal healthy obese individuals (Table 4). Values were statistically significant in diabetes and IFG (P < 0.001).

Table 4. Fasting plasma glucose (FPG) levels in the study subjects.

Clinical condition	Subjects (n = 105)	Fasting plasma glucose (FPG) Mean ± SD	'P' Values*
Normal	**93**	**88.35±8.94**	
Diabetes	**4**	**209.5±64.53**	**P<0.001**
IGT	**4**	**104.00±20.25**	**P=0.002**
IFG	**4**	**132.00±23.17**	**P<0.001**

***** Values are statistically significant.

Similarly two hour OGTT was significantly higher in diabetes and pre-diabetes as compared to normal healthy obese individuals (P < 0.001) (Table 5).

Table 5. Two hour OGTT status in study subjects.**

Clinical condition	Subjects (n = 105)	2-h OGTT Mean ± SD	'P' Values*
Normal	**93**	**91.92±21.84**	
Diabetes	**4**	**347.00±141.16**	**P<0.001**
IGT	**4**	**148.00±8.17**	**P<0.001**
IFG	**4**	**125.00±18.65**	**P=0.003**

*****Values were statistically significant,

****** Venous plasma glucose 2-hour after ingestion of 75 g of oral glucose load.

The screening effort undertaken in this study resulted in the detection of 4 new cases of diabetes and 8 pre-diabetes cases based on the WHO criteria. Among pre-diabetes 4 cases were of impaired fasting glucose (IFG) and 4 were impaired

glucose tolerance (IGT). The prevalence of undiagnosed diabetes and pre-diabetes among class III and class IV healthy obese employees was 3.8% and 7.6 % respectively making total of 11.4%.

Discussion: Diabetes in adults is now a global health problem, and populations of developing countries now face the greatest risk [17]. 75% of people with diabetes will reside in developing countries by the year 2025, as compared with 62% in 1995[3].

The prevalence of diabetes in urban South Indian population was 12%, which included 7.2% of known diabetic subjects and 4.8% undiagnosed diabetic subjects, while the prevalence of impaired glucose tolerance was 5.9% [18]. The national survey of diabetes in India, covering all the regions of the country shows that the prevalence of diabetes is high in urban India. There is a large pool of subjects with impaired glucose tolerance at a high risk of conversion to diabetes [19].

Our study is comparable with other studies in India [18-20]. According to Ramachandran, et.al study [19] found that subjects under 40 years of age had a higher prevalence of impaired glucose tolerance (IGT). In our study the mean age of patients with IGT was 37.65 years. Oberlinner, et.al [6] screened employees at workplace and found among high-risk employees, 20 new cases of pre-diabetes and 8 cases of diabetes were detected in 84 employees assessed by OGTT.

We observed that the levels of HbA1c (Table. 3) not statistically significant in diabetes and pre-diabetes, compared to normal subjects. We found that HbA1c is not effective screening test for diagnosis of diabetes and pre-diabetes unlike Bennett, et.al.[21] and Qvist et.al.[22] study. Arnold, et.al.[23] suggested that number of conditions can lead to a falsely elevated or a falsely low HbA1c level. According to American Diabetic Association (ADA) individuals with IFG or IGT may have normal or near normal glycated hemoglobin levels and individuals with IGT often manifest hyperglycemia only when challenged with the oral glucose load used in the standardized OGTT [8]. Our study also showed similar results as ADA [8].

In our study fasting plasma glucose (FPG) concentration and 2-h OGTT were statistically significant in diabetes and pre-diabetes as compared to normal healthy obese individuals. Hence, fasting plasma glucose (FPG) concentration and 2-h OGTT are effective screening tools for the screening of diabetes and pre-diabetes. Out of these (OGTT) is the 'gold standard' for diagnosing pre-diabetes /diabetes, although it is inconvenient for the patient and time consuming. Because impaired glucose tolerance (IGT) can not be diagnosed by FPG concentration alone.

Pre-diabetes is often an incidental finding in people who are undergoing biochemical testing for diabetes. The people with pre-diabetes who are overweight or obese require intensive lifestyle interventions [12]. Hence, the early detection of risk of diabetes and appropriate life style intervention such as weight reduction, changes in life style, dietary habits modification and increased physical activity could greatly help in preventing or postponing the onset of diabetes and thus reducing the burden of the disease on community and nation as whole. Thus our study helps in the early detection of pre-diabetes and diabetes among high risk adults. Screening and awareness programmes are needed in middle age obese population to control the rising epidemic of diabetes and its complications.

Given the likely magnitude of unrecognized diabetes and pre-diabetes cases, further interventions are being implemented targeting all employees and not just those who require routine occupational medical examinations.

Conclusion: The findings of our study and their implication would help to design disease prevention and to reduce morbidity in healthy obese individuals. We recommend that screening for the diabetes and pre-diabetes should be employed as part of routine occupational health check-up programme. We found that HbA1c alone is not effective screening test for diagnosis of diabetes and pre-diabetes in obese individuals. We conclude that OGTT may be the gold standard test to identify undiagnosed diabetes and pre-diabetes in healthy obese individuals.

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