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Prediabetes And Undiagnosed Diabetes Mellitus Among White-Collar Employees: A Covert Peril

Dr Gargi Sarangi[1], Dr Brijesh Mukherjee[2]
[1]*Consultant Physician, Sambandh Finserve Private Limited, Rourkela, Odisha.*
[2]*Associate Professor (Biochemistry), Hi-tech Medical College and Hospital, Rourkela, Odisha.*
Corresponding author: Dr Brijesh Mukherjee,

ABSTRACT: *Introduction: Globally half of all cases of diabetes mellitus are either undiagnosed or cases of prediabetes. These cases represent the unseen but clinically important burden of diabetes, with significant concurrent metabolic derangements and a long-term impact on health care and its costs.*
Objectives: With an aim to estimate the frequency of prediabetes and undiagnosed diabetes in the adult population with sedentary life style, a camp was organized at a private firm to screen the employees by estimating fasting plasma glucose (FPG) and glycosylated hemoglobin (HbA1c).
Materials and methods: A total of 218 individuals were selected for analysis after excluding the known diabetic cases. Height, weight, pulse, blood pressure (BP), waist circumference, and body mass index (BMI) were measured. Plasma fasting sugar and fasting serum lipid profile were analyzed. The HbA1c was estimated in hyperglycemic subjects.
Results: The frequency of hyperglycemia in the study population was found to be 28.4%. The total frequency of prediabetes was 17.4% and that of undiagnosed diabetes was 11%. The raised sugar could be significantly associated with age, high blood pressure, BMI and hypertriglyceridemia. Triglyceride and VLDL depicted significant odds ratio (OR) to predict the risk factor for diabetes.
Conclusion: The hidden burden of diabetes in population with sedentary life is quite high. This if not taken care of would result in a public health catastrophe.
Keywords: *Diabetes, Dyslipidemia, Fasting plasma glucose, Glycosylated hemoglobin, Prediabetes.*

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I. Introduction:

The American Diabetes Association (ADA) defined diabetes as, "a group of metabolic disorders characterized by hyperglycemia resulting from defects in insulin secretion, insulin action or both" [1]. In recent times it has been observed that there has been a steep rise in the prevalence of metabolic syndrome [2] and of type 2 diabetes [3] worldwide, which is extremely pronounced in Asian countries [3] and is particularly remarkable in India [4]. Diabetes prevalence is increasing in every country with a rise in its term of claiming of human lives as well as the costs to society. Estimated surveys show that:

• In 2011, 366 million people, or approximately 8.3% of the world's adult population, lived with diabetes and according to IDF data it has risen to 371 million in 2012 [5].
• By 2030 this number is expected to grow to 552 million [6].
• China has the largest number of people with diabetes in the world (92 million).
• Worldwide, only half of all people with diabetes are diagnosed [6].

In a developing country like India there has been a rapid change in the life style of people. Obesity and Diabetes Mellitus go hand in hand and have become major health problems. The prevalence rate of diabetes has increased dramatically over the years since the time the first national survey was undertaken, in 1971. At that time the prevalence was 2.3% in the urban areas and 1.2% in the rural areas. The most recent studies suggest prevalence rate of between 15-20% in urban areas and half of that in rural areas. In 2011, India had 62.4 million people with type 2 diabetes, compared with 50.8 million the preceding year, according to the International Diabetes Federation (IDF) and the Madras Diabetes Research Foundation. The nationwide prevalence of diabetes in India now is 9% with an increase of upto 20% in the relatively prosperous southern cities. By 2030, the IDF predicts, India will have 100 million people with diabetes. Complications of diabetes, such as coronary artery and peripheral vascular disease, stroke, diabetic neuropathy, gangrene, renal failure and blindness leads to increasing disability, reduced life expectancy and enormous health costs.

II. Objectives:

With an aim to screen for undiagnosed DM and prediabetic profile, in the adult population of Rourkela city and estimate the frequency of DM and prediabetic cases in the community involved in sedentary jobs, a camp was arranged in a private firm.

III. Materials And Methods:

A camp was organized at Sambandh Finserve Private Limited, Rourkela after obtaining prior permission of the management of the firm. Most of the employees of the firm were involved in desk jobs with minimal physical activity. Concise instructions and preparatory information (overnight fasting of 8 hours) inscribed in pamphlets, in Odia and English, were distributed among all the employees. This camp was approved by our Institutional Ethics Committee.

A total of 252 individuals got enrolled for the camp. All individuals were asked to sign the informed consent form after registration. Height, weight, and waist circumference were measured, and BMI was calculated for all of them. Pulse and BP were measured by manual sphygmomanometer in sitting position.

Fasting plasma glucose and serum lipid profile (cholesterol, TG, HDL) were estimated immediately after in automated analyzer (Erba Manheim EM 200) and HbA1c in D10 hemato analyzer. The LDL was calculated by Friedewald's method. Individuals with FPG >100 mg/dl were subjected to estimation of HbA1c to assess their metabolic state and categorize them as diabetic and prediabetic.

Twenty four known diabetic cases also got enrolled, which were excluded during the analysis in order to get the actual burden of undiagnosed cases. Ten individuals refused to sign the informed consent and were also excluded from the study.

Individuals were categorized as normoglycemic (FPG $\leq$ 100 mg/dL) and hyperglycemic (FPG > 100 mg/dL). All hyperglycemics were subcategorized as prediabetic and diabetic as per the diagnostic criteria laid by the American Diabetes Association [7].

Diabetics:

Individuals with FPG $\geq$ 126 mg/dL and/or HbA1c $\geq$ 6.5%. If any patient has A1c $\geq$6.5%, but FPG < 126 mg/dL, that person was considered as diabetic.

Prediabetics:

Individuals with FPG between 101 and 125 mg/dL and/ or HbA1c 5.7 and 6.4%.

Estimation of HbA1c was by the ion exchange high performance liquid chromatography method as certified by the National Glycohemoglobin Standardization Program, which is supposed to be advantageous over FPG and oral glucose tolerance testing because of its greater pre-analytical stability and minimum interference by day-to-day activity and stress [8].

Desirable ranges for the variables measured were as per Atherosclerotic Cardiovascular Disease Risk Categories given in Table 1[9].

Statistical analysis was performed using Graph Pad Prism. Causal relationship between the variables was determined by chi-square ($\chi 2$) test. The OR with 95% confidence interval (CI) was estimated using logistic regression predicting the factors associated with diabetes. For two-tailed p-values of <0.05 were considered significant, with 95% CIs.

IV. Results:

The data analysis revealed that 67.9% (n = 148) of the participants were young adults of age group less than 40 years. The frequency of hyperglycemia was calculated to be 28.4% (62/218) in this community (Table 2). The incidence of prediabetes and diabetes was observed to be respectively, 17.4 (n = 38) and 11% (n = 24). About 58 % (n = 36) of hyperglycemic subjects depicted raised HbA1c levels.

The mean age of participants was 37.4 ± 11.1 years, frequency of hypertension was 40.82%, 53.67% had greater waist circumference, and 72.48% recorded high BMI, of which 32.91% (n = 52/158) were obese. Family history was positive in 40.37% cases and the diet of 63.3% study subjects were found to be mixed. Dyslipidemia was represented in 57.5% of the study population.

The $\chi 2$ test in Table 3 revealed that age group, blood pressure, and BMI have a significant ($p < 0.05$) difference in proportion within each group.

Participants of age group >40 years have more risk of diabetes as compared with those participants within the age group 20 to 40 years. As compared with subjects with normal BMI, obese (≥30 kg/m2) people are more prone to be diagnosed as diabetes ($p < 0.01$).

As shown in Table 4, associated hypertriglyceridemia (TG $\geq$ 150 mg/dL) raises the risk 4.8 ($p < 0.05$) times for diabetes against the desirable level of TG. Individuals with elevated VLDL (≥ 30 mg/dL) are at a 4.27 times more risk for diabetes in comparison with those with normal levels ($p < 0.05$).

Pearson correlation analysis demonstrated significant positive correlation between FPG with age ($p < 0.01$), BMI ($p < 0.05$), BP ($p<0.05$), TC ($p < 0.001$), TG ($p<0.01$) and very low-density lipoprotein (VLDL; $p < 0.001$) as tabulated in Table 5.

Table 1: Desirable range for the measured variables

Variables	Desirable range
Waist circumference	Men: <94 cm; Women: <80 cm
BMI	18.5–24.9 kg/m2
Pulse	60-90 bpm
BP	<130/80
FPG	<100 mg/dl
HbA1c	<5.7%
Serum cholesterol	<200 mg/dl
Serum TG	<150 mg/dl
Serum LDL	<130 mg/dl
Serum HDL	>50 mg/dl
Serum VLDL	<30 mg/dl

Table 2: Distribution of study population according to fasting blood sugar level

Dependent variables	Frequency	Percentage
Normoglycemic (≤110 mg/dl)	156 (n=218)	71.6
Prediabetic (>110-<126 mg/dl)	38 (n=218)	17.4
Diabetic (≥126 mg/dl)	24 (n=218)	11.0
Raised HbA1c (≥5.7%)	36 (n=62)	58

Table 3: Percentage distribution of diabetes status by physiological characteristics by chi-squared test.

Variable	Normogycemic	Prediabetic	Diabetic	Total	p-value
Age group in years					
20-40	120	20	6	148	
>40	36	18	18	70	<0.01**
Gender					
Males	87	23	18	128	
Females	69	15	6	90	0.36
BP (mm Hg)					
Normotensive	119	6	4	129	
Hypertensive	37	32	20	89	<0.01**
BMI (kg/m^2)					
Normal (18.5–24.9)	56	2	2	60	
Overweight (25–29.9)	81	19	6	106	
Obese (≥30)	19	17	16	52	<0.01**
Waist circumference **(cm)**					
Normal	70	16	15	101	
High	86	22	9	117	0.23
Diet					
Vegetarian	56	13	11	80	
Mixed	100	25	13	138	0.6
Family history					
Positive					
Negative	64	14	10	88	
	92	24	14	130	0.89

*$p < 0.05$ significant difference

Table 4: Lipid profile association with diabetes

Variables	Odds ratio	95% CI Lower	95% CI Higher	p-value
Total cholesterol (mg/dl) Desirable (<200) Moderate and high risk (≥200)	1..09	0.60	2.00	0.77
TG (mg/dl) Desirable (<150) Moderate and high risk (≥150)	4.80	2.65	8.69	<0.01**
HDL (mg/dl) Desirable (≥50) Moderate and high risk (<50)	1.31	0.70	2.46	0.39
LDL (mg/dl) Desirable (<129) Moderate and high risk (≥129)	1.64	0.89	3.02	0.15
VLDL (mg/dl) Desirable (<30) Moderate and high risk (≥30)	4.27	2.38	7.64	<0.01**

(Logistic regression, *p < 0.05 significant difference)

Table 5: Pearson correlation between fasting plasma glucose and physiological and biochemical parameters

Plasma glucose	Pearson correlation	Significance (two tailed)	N
Age	0.41	<0.001**	218
Pulse	0.11	0.08	218
BP	0.21	0.008*	218
BMI	0.16	0.021*	218
Waist circumference	0.11	0.32	218
Plasma glucose	1		218
Cholesterol	0.19	0.007*	218
TG	0.36	<0.001**	218
LDL	0.09	0.13	218
HDL	-0.08	0.61	218
VLDL	0.34	<0.001**	218

*p < 0.05 significant difference

V. Discussions:

The result of our study revealed an incidence of prediabetes and undiagnosed diabetes, together, to be 28.4%. Further analysis of HbA1c in these subjects confirmed diabetes in 16.5%, whereas 11.9% individuals were in prediabetic group. The prevalence of newly detected diabetes in Indian Council of Medical Research–India Diabetes (ICMR–INDIAB) study population (n = 13,055) was reported to be between 2.3-7.6% in different states. The prevalence was significantly lower in rural areas compared with urban centers of India. The prevalence of prediabetes in the same study was between 8.1-14.6% [10].

There are no data available in the city of Rourkela regarding prevalence of diabetes and prediabetes due to the unavailability of endocrinologist and sufficient numbers of certified diabetologists. A significant proportion of diabetics are catered by primary care providers and sometimes by chemists. The absence of sufficient number of quality diagnostic labs adds to the problem. Hence our study can be considered as a forewarning for the alarming situation in this city.

The major participants in this camp were found to be young individuals (<40 years) who represented 67.9% of the whole study population. This reflects the magnitude of awareness among the youth toward their health. The fear of dietary restrictions and compulsion of lifestyle changes play an important role in reluctance for screening of diabetes among the general population.

The rising trend of FPG and HbA1c correlated significantly with age and reflected the impact of aging on IR. Our study showed significant positive correlation with BMI, which was found to be an independent risk factor for DM. Indian's body fat content is comparatively higher as compared with their peer groups in the Western countries. As per WHO expert consultation, appropriate BMI should be revised and standardized based on the regional population anthropometric measurements [11, 12].

The FPG correlated positively with serum cholesterol, TG and VLDL but dyslipidemia in the form of hypertriglyceridemia and raised VLDL level only were indicated to be significant risk factors for diabetes and prediabetes. Park et al, [13] in their study, had proposed that the best marker for IR was TG. This could be explained by the fact that significantly higher number of individuals were in the prediabetic group, who might not have developed dyslipidemia and metabolic derangements to be significantly associated with FPG and HbA1c. Early diagnosis and management would improve not only the health status of the individual, but also decrease the financial burden on the society.

Some of the limitations in this analysis were: (i) the subjects did not give addiction history including alcohol and other substances of abuse in spite of convincing them that their data would be kept confidential. Hence their effects on blood glucose levels could not be assessed .(ii) Postprandial plasma glucose was not evaluated; (iii) factors affecting glucose homeostasis like endocrine, thyroid and pituitary imbalances were not estimated.

VI. Conclusion:

The findings revealed in this study can set an example for the health system to initiate and implement awareness programs and strategize health care policies to combat the catastrophic burden of this epidemic. Early diagnosis no doubt would reduce the disease burden and will improve quality of life. It will also decrease the huge cost of treatment. More health camps in other firms with similar sedentary jobs and large-scale multicentric studies can reflect more accurate data on burden of the disease.

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