Research Article

Prevalence of impaired fasting glucose in an urban population of central India

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Received: December 01, 2016; **Accepted:** December 15, 2016

ABSTRACT

Background: According to International Diabetes Federation diabetes Atlas in India, 42.2 million people have pre-diabetes. Risk of development of diabetes in such people is high. **Objectives:** To determine the prevalence of impaired fasting glucose (IFG) in urban areas of Gwalior and to find a relation between IFG and various anthropometric variables. **Materials and Methods:** It was a cross-sectional community-based survey done on 1000 participants in city of Gwalior between June 2014 and October 2015. Fasting capillary blood glucose was determined using a glucometer after 8 h of fasting. Association between IFG and anthropometric parameters, total cholesterol, triglyceride, alcohol intake, and smoking was obtained. **Results:** Out of 1000 participants screened, 229 (22.9%) had IFG; hence, prevalence was 22.9%. Mean age, body mass index (BMI), waist–to-hip ratio (WHR), and fasting blood glucose (FBG) of participants with IFG were 37.85 ± 3.23 years, 25.29 ± 2.60 kg/m^2, 0.943 ± 0.05, and 108.83 ± 5.00 mg/dl, respectively. IFG was mostly observed in male population (69.86%), with non-vegetarian diet (68.56%) and population who had a family history of diabetes mellitus (74.67%). Out of 229 participants with IFG, 162 (70.74%) had BMI >23 kg/m^2, 203 (88.64%) had raised WHR, 142 (62%) had raised total cholesterol level, 97 (42.35%) were alcoholic, and 126 (55.02%) were smokers. There was a significant difference in mean BMI (P = 0.001), WHR (P = 0.023), and FBG (P = 0.0001) in IFG population as compared to euglycemic population. In conclusion, the present study has shown that the prevalence of IFG was 22.9% with males showing a higher prevalence. **Conclusion:** Participants with raised BMI, WHR, and non-vegetarian diet had higher incidence of IFG. Participants having IFG had raised total cholesterol and significantly raised triglyceride levels. No significant association was found between IFG and smoking/alcohol.

KEY WORDS: Impaired Fasting Glucose; Prevalence; Diabetes Mellitus; Body Mass Index; Euglycaemia

INTRODUCTION

Participants with pre-diabetes have a high risk of developing diabetes mellitus (DM) in the near future, if proper care is not taken by them. Pre-diabetes is the state of impaired glucose tolerance (IGT) or impaired fasting glucose (IFG) (fasting blood glucose = 100-125 mg/dl) either alone or in combination. Diagnosis of pre-diabetes can be performed using blood sugar test such as fasting blood glucose and oral glucose tolerance test.[1]

Access this article online	
Website: http://www.ijmsph.com	**Quick** Response code
DOI: 10.5455/ijmsph.2017.1267215122016	

Currently, around 314 million people are living with pre-diabetes, and it is expected to rise to 500 million by 2025. As per the present situation, up to 70% of the pre-diabetic patients eventually get diabetes.[2]

Reports have also shown that around 5-10% pre-diabetes people become diabetic annually.[1,3] In one meta-analysis,

annualized incidence rates of diabetes for isolated IGT (4-6%) and isolated IFG (6-9%) were lower than those for IFG and IGT combined (15-19%).[4]

With this background, this study was undertaken to find out the prevalence of IFG in central India. Till date, no large-scale prevalence study has been carried out in this geographical area. Considering the potential reversibility of this condition, early detection is very important for timely intervention so that the participants may be reverted back to a euglycemic state.

MATERIALS AND METHODS

The present cross-sectional community-based survey was done on 1000 participants of either sex between ages of 18 and 65 years in city of Gwalior from June 2014 to October 2015. Written informed consent from all patients and Institutional Ethical Committee approval was obtained before starting the study. The population surveyed primarily consisted of local population, hospital staff, nursing students, and office workers.

All apparently healthy individuals between ages 18 and 65 years were included in the present study. Previously diagnosed cases of DM, hypertension, hypertriglyceridemia, known cases of chronic kidney disease, chronic liver disease, tuberculosis and bronchial asthma, and other chronic inflammatory diseases were excluded from the study.

In anthropometric measurement, height (meters), weight (kgs), body mass index (BMI) (kg^2), and waist and hip circumference (cm) were recorded. Hypercholesterolemia is defined as serum cholesterol more than 200 mg/dl and raised serum triglyceride level is defined as levels more than 150 mg/dl as per NCEP guidelines. BMI is defined as high if more than 23 in Asian population as per American Diabetes Association 2015. Dietary habits were divided into vegetarian and non-vegetarian with vegetarian diet being defined as a diet rich in starch and fibers and consumption of eggs being included in vegetarian diet. Smoking history of 10 packs per years was considered significant. Alcohol intake of more than 20 g/day in females and 40 g/day in males for 10 years was considered significant.

Fasting capillary blood glucose was determined using a glucose meter (Accusure Soul/One Touch Glucometer). The participants were instructed to keep an overnight fast after which fasting glucose was determined. Capillary blood glucose was adopted in favor of venous plasma glucose estimations, as it was neither practical nor feasible to collect, handle, and store such a large volume of samples in an epidemiological study of this magnitude. Fasting total cholesterol and total triglyceride were determined by collected fasting venous blood sample.

All the statistical analyses were performed using IBM SPSS version 20. Mean and standard deviations were calculated for time-varying variables, and percentages were calculated for categorical variables. $P < 0.05$ was considered as statistically significant.

RESULTS

Out of 1000 participants screened, 771 (77.1%) were euglycemic and 229 (22.9%) were having IFG.

In age group of 18-29, 30-49, and 50-65 years, male had a mean blood glucose level of 109.36, 109.11, and 107.5 mg/dl, respectively, whereas female had a mean blood glucose level of 107.15, 108.68, and 109.81 mg/dl, respectively, among the IFG population (Table 1).

Prevalence of IFG among male was higher in the age group of 30-49 years [108 (67.50%)], followed by participants with 18-29 years (30 [18.75%]); similarly, prevalence was higher in the age group of 30-49 years (45 [65.21%]) in female group.

Out of 229 IFG population, 142 (62%) had raised cholesterol level among them 103 (72.53%) were male and 39 (27.47%) were female and 174 (75.98%) had reported raised serum triglyceride, out of that 123 (70.68%) were male and 51 (29.31%) were female.

Out of 229 IFG patients, 162 (70.74%) had BMI >23 kg/m^2, out of that 118 (72.83%) were males and 69 (42.59%) were

Table 1: Comparing different parameters among participants with IFG and euglycemia

Parameters	Euglycemic (*n*=771)	IFG (*n*=229)	*P* value
Age (years)*	36.11±2.32	37.85±3.23	NS
BMI (kg^2)*	22.10±2.33	25.29±2.60	0.001
WHR	0.7919±0.055	0.943±0.05	0.023
FBG (mg/dl)*	85.83±6.748	108.83±5.00	0.0001
Gender			
Male	449 (58.23)	160 (69.86)	0.002
Female	322 (41.76)	69 (30.13)	
Diet			
Non veg	338 (43.84)	157 (68.56)	<0.0001
Veg	433 (56.16)	72 (31.44)	
Family history of DM			
Present	171 (22.18)	171 (74.67)	<0.0001
Absent	600 (77.82)	58 (25.32)	

Data are expressed as no of patients (%), *Data are expressed as mean±standard deviation (SD), NS: Not significant, BMI: Body mass index, WHR: Waist–hip ratio, FBG: Fasting blood glucose, DM: Diabetes mellitus, IFG: Impaired fasting glucose

females ($P < 0.0001$). In 203 (88.64%) IFG patients, raised waist hip ratio (WHR) was recorded, out of that 144 (70.93%) were males and 59 (29.06%) were females ($P < 0.0001$).

Out of 229 IFG patients, 97 (42.35%) were alcoholic, whereas in euglycemic cohort, 374 (48.50%) participants were alcoholics ($P = 0.11$). Among IFG population, 126 (55.02%) were smokers, whereas in euglycemic population, 375 (48.63%) were smokers ($P = 0.104$).

DISCUSSION

According to the WHO and International Diabetes Federation estimates, India has the largest number of people with diabetes, and the trend will continue in the future. The available prevalence rate from different studies in our country cannot be extrapolated to the whole population as there is heterogeneity in our population with respect to cultural and behavioral practices. Moreover, a comparison of IFG levels and its attributes with corresponding data from other countries can provide a sense of direction our country is taking in response to the global "diabetic pandemic" relative to other countries.

Sahai and Vyas included 130 participants in the similar study and reported the prevalence of 18% which is similar to what is reported by the present study (22.9%).[2] Flegal et al. did a similar study in the US and reported IFG prevalence of 26%.[5]

Another study by Chow et al. in a rural area of Andhra Pradesh reported a lower prevalence of IFG (15.5%).[6] A similar study done in the USA reported a higher prevalence in male population compared to females which is similar to the results reported by the present study, whereas Sahai and Vyas and Shaw et al. observed no such difference among genders.[2,7] Balagopal et al. carried out a similar study in a rural population of Tamil Nadu which reported a prevalence of 12.1% compared to the present study, lower prevalence may be due to purely rural setting against urban in our study.[8]

Obesity has been one of the central determinants of developing an insulin-dependent state, and our study, by utilizing BMI and WHR as a quantitative indicator for the same, has added to the evidence. Kumar et al. performed The Kolkata Policeman Study reported a strong correlation of IFG with circumference and WHR but not with BMI, whereas in our study, BMI and WHR were significantly higher. Mean BMI in the present study was 25.29 ± 2.60 kg/m^2 in IFG population which was significantly high compared to euglycemic group. The Kolkata Policeman Study reported insignificantly lower BMI (23.87 ± 2.83 kg^2).[9] Sahai and Vyas also reported a lower BMI (19.2 ± 2.8 kg^2, $P > 0.05$) compared to the present study.[2] The difference could be due to difference in genetic factors, cultural factors, lifestyle, and rural–urban variations.

Prevalence of IFG among male (67.50%) and female (65.21%) was higher in the age group of 30-49 years in the present study. Qureshi et al. in a similar study of 370 participants reported that prevalence was highest among the age group of 51-60 years (16.07%).[10]

A positive family history of diabetes was important enough to have a significant association with IFG. Family history of diabetes was recorded in 74.67% of the IFG population in the present study. Although another similar study found a lower percentage of family history (12.26%) in IFG population.[10] The lack of awareness about status of diabetes among family members might be the reason for such a high percentage of patients having a family history in the present study. A result of this nature was adequately substantiated from the comparison of the conclusions of the ICMR-INDIAB study.[11] Although the NHANES study did not analyze IFG levels with a family history of type 2 DM, it had reported an insignificant association between race and IFG.[12]

The present study did not reveal any association of significance between either alcohol intake or tobacco smoking with IFG ($P = 0.11$ and $P = 0.104$, respectively). The NHANES study which had tested cigarette smoking found strong statistical association; however, the relationship with alcohol was not tested.[12] No Indian study among those considered for comparison had tested alcohol intake and cigarette smoking as risk factors for IFG.

Participants having IFG showed higher levels of cholesterol and triglycerides, but statistical association cannot be applied as cholesterol and triglyceride levels of euglycemic population was not done due to time and financial constraints and the large sample size. Impaired serum cholesterol was found positively associated with IFG in the NHANES study.[12] This association was not tested in the Indian studies under our purview. Triglycerides were not put into study in any of the stated surveys.

Development of IFG level was most commonly recorded in patients who followed non-vegetarian diet ($P < 0.0001$). The nature of diet vegetarian against non-vegetarian was not tested for its association with IFG in any of the Indian studies. However, in the NHANES study, the adoption of prudent dietary recommendations was associated with reduced incidence of developing IFG levels.[12]

Adequate follow-up was not available. Every participant should have been subjected to adequate follow-up, but due to time and financial constraints and unwillingness on the part of participants, it was not possible to do adequate follow-up.

CONCLUSIONS

This study aims at providing an indicator to the burden of the disease; Central India stands to face in the following decades.

There has been a secular trend in the increase of diabetes over the years with multiple studies confirming the same, and with India being called no less than the "Diabetic Capital of the World," there seems to be no slowing down in the apparent epidemic with high prevalence rates of pre-diabetic indicators across the country.

It was found that the total prevalence of IFG was 22.9% with males showing a higher percentage compared to females. Participants with raised BMI had more incidence of IFG compared to participants having normal BMI. Participants who had higher WHR also had a higher incidence of IFG. Non-vegetarian participants had a higher incidence of IFG. Participants having IFG had raised cholesterol and significantly raised triglyceride levels. No significant association was found between IFG and smoking and alcohol.

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How to cite this article: Sahai S, Tyagi P, Shah N. Prevalence of impaired fasting glucose in an urban population of Central India. Int J Med Sci Public Health 2017;6(5):863-866.

Source of Support: Nil, **Conflict of Interest:** None declared.