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Original Article

Prediabetes in South Indian rural adolescent school students

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Abstract

Prediabetes is a condition with blood glucose levels higher than normal but not high enough to be diagnosed as diabetes. Most people with prediabetes are asymptomatic but are considered to be at a high risk of developing heart disease and stroke. 140 students of both sexes between ages 14-18 years were given a predesigned questionnaire to obtain information on socio-economic status and family history of Diabetes mellitus. A fasting plasma glucose level was measured and 6.8% of students were in the prediabetic range (>100 mg/dl). No significant correlation was found between fasting plasma glucose and Body Mass Index or waist to hip ratio. 41.5% of the boys and 10.3% of the girls had a family history of DM but were in euglycemic range. It is beneficial to identify people with prediabetes so that appropriate lifestyle modification may be done to prevent or postpone onset of Diabetes mellitus.

Introduction

Diabetes mellitus is a chronic disease with increased concentration of glucose in blood. Prevalence of prediabetes is increasing worldwide and experts have projected that more than 470 million people will have prediabetes by 2030. Prediabetes is defined as fasting blood sugar level between 110 mg/dl to 125 mg/dl as per WHO guidelines and 100 mg/dl to 125 mg/dl as per American Diabetes Association (ADA) (1, 2). Fasting blood sugar ≥126 mg/dl is considered as Diabetes mellitus. India leads the world with largest number of diabetic subjects and according to the Diabetes Atlas 2006 published by the International Diabetes Federation, the number of people with diabetes in India currently around 40.9 million is expected to rise to 69.9 million by 2025 unless urgent preventive steps are taken (3, 4). Before people develop type 2 Diabetes mellitus (DM), they almost always have prediabetes wherein blood glucose levels are higher than normal but not high enough to be diagnosed as diabetes. 5-10% of people per year with prediabetes will progress to diabetes, with the same proportion converting back to normoglycaemia. Prediabetes is associated with the simultaneous presence of insulin resistance and β-cell dysfunction abnormalities that start before glucose changes are detectable. Most people with prediabetes do not show symptoms but are considered to be at a high risk of developing heart disease and stroke. Recent research has shown that some long term damage to the cardiovascular system could start even in the prediabetic stage. With prediabetes the subtle balance between glucose and insulin has been thrown off. Impaired fasting glucose (IFG) is a prediabetic state with insulin resistance and cardiovascular risk, although it carries a lesser risk than impaired glucose tolerance. IFG may sometimes progress to type 2 DM in less than 3 years (5). The WHO criteria for

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IFG differs from the American Diabetes Association (ADA) criteria as the normal range of blood glucose is defined differently. The WHO in 1998 recommended that the fasting plasma glucose (FPG) threshold should be reduced from 140 to 126 mg/dl for diagnosing diabetes. This reduction in FPG was justified based on epidemiological studies that the cut-off level of 126 mg/dl or greater included individual with greater degree of hyperglycemia and there was also found to be an increase in the prevalence of diabetic retinopathy beginning at approximately 126 mg/dl (6, 7). In 2003, the FPG range was further lowered to 125 mg/dl to categorise people as having prediabetes so that affected individuals would more likely adopt early lifestyle interventions to reduce potential risk of developing diabetes in future (8). The ADA population and patient based studies have shown that the microvascular and macrovascular complications of diabetes are present in the prediabetic state as well (9). The main objective of the study was to see the prevalence of prediabetes if any in school students between 14-18 yrs of age.

Methods

A total of 140 students belonging to both sexes, 82 boys and 58 girls between 14 to 18 years, studying in class X in a government run school were included in the study. A pre-designed questionnaire to obtain information regarding socio-economic status, nutrition, physical activity, diet and family history of diabetes was given to the subjects. Anthropometric data like, height measured with stadiometer and weight was measured with a digital weighing scale. BMI was calculated using standard formula. Waist and hip measurements were taken with a measuring tape and waist hip ratio (WHR) was calculated. A WHR of 0.8 was taken as cut-off value for both male and female participants. A fasting plasma glucose was measured with One Touch Glucometer (Johnson & Johnson Co.) in all the subjects after an overnight 10 hr fast. Pre-diabetes was defined as fasting plasma glucose between 100 mg/dl to 125 mg/dl. An informed consent was taken from all the subjects/ Principal of the school and institutes ethics committee permission was obtained.

Results

Results were analysed and expressed in terms of percentages and p value was determined using statistical calculator.

A total of 140 students of class X participated in the study consisting of 82 boys and 58 girls.

The mean age of all the study participants was 15.4 years (SD±0.864) with mean age of boys at 15.46 years (SD±0.975) and girls 14.75 years (SD±0.431).

The fasting blood sugar was correlated with BMI, WHR and Family history of the participants and tabulated as given below :

TABLE I : Fasting blood sugar levels in study group : Boys & Girls.

Fasting blood glucose mg/dl	*Total no of study subjects*	*Boys*	*Girls*
<70	2	2	0
71-80	18	12	6
81-90	68	40	28
91-100	42	22	20
>100	10	6 (7.32%)	4 (6.89%)

Of the total study participants (140) 10 students had fasting plasma glucose more than 100 mg/dl which is 6.89%.

7.32% of boys and 6.89% of the girls had fasting plasma glucose more than 100 mg/dl.

TABLE II : BMI in study group : Boys and Girls.

BMI	*Boys*	*Girls*	*FBS mg/dl*
25-30 kg/m^2 (overweight)	0	6	71-90
>30 kg/m^2 (obese)	0	2	81-90

Students with BMI >25 kg/m^2 were considered overweight and those with >30 kg/m^2 were considered obese.

None of the boys were overweight or obese in the study group. 6 girls were overweight and 2 girls were found to be obese. However, their fasting blood sugar was within normal range (<90 mg/dl). There was no correlation between plasma glucose and BMI in this study.

TABLE III: WHR in study group.

Gender	*WHR (>0.8)*
Boys (n=82)	56 (68%)
Girls (n=58)	48 (83%)
Total (n=140)	104 (74.2%)

68% (56) boys and 83% (48) girls had a high WHR (> 0.8).

Out of 10 students who had a high plasma fasting glucose (>100 mg%), only 8 students had a WHR > 0.8 and 2 students had WHR < 0.8.

TABLE IV: WHR in prediabetic and non-diabetic subjects.

WHR	*Prediabetic*		*Non Diabetic*		*Total*
	Boys	*Girls*	*Boys*	*Girls*	
> 0.8	4	4	52	44	104
< 0.8	2	0	24	10	36
Total	6	4	76	54	140

Out of 140 students, 10 students were in the prediabetic range (FPG > 100 mg/dl). Among the 10 students, 4 boys and 4 girls had a WHR of > 0.8 and 2 boys had WHR < 0.8.

52 boys and 44 girls were in the non-diabetic range with WHR > 0.8 and 24 boys and 10 girls had a WHR < 0.8.

Relation between prediabetes and WHR was statistically calculated and was not found to be significant (p>0.05).

TABLE V: Family history of Diabetes mellitus in study group.

No. of students	*Family H/O of DM (Total)*	*Paternal side*	*Maternal side*	*Not specified*
Boys (82)	34 (41.5%)	18 (52.9%)	2 (5.8%)	14 (41.2%)
Girls (58)	6 (10.3%)	4 (66.7%)	2 (33.3%)	–

Out of 82 boys, 34 (41.5%) had family history of DM with 18 (52.9%) showing paternal history and only 2 (5.8%) showing maternal history. Among 58 girl participants, 6 students (10.3%) had family history of DM out of which 4 (66.7%) were showing paternal history and 2 (33.3%) were showing maternal history. Among the 82 boys, 14 students did not specify the presence of DM history in maternal or paternal side. However, all the study participants who had family history of DM, did not show FPG in the prediabetic range.

2 boys who had fasting blood glucose on the higher side of the prediabetic range (112 mg/dl) showed family history of hypertension and coronary artery disease.

Discussion

There is a high incidence of Diabetes in India which is increasing rapidly. International Diabetes Association has estimated that there would be around 70 million cases of Diabetes mellitus in India by the year 2025 (4, 10). Studies have shown that it sets in a decade earlier in Indians than West (11). Anthropometric indiactors like WHR and BMI are associated with a greater possibility of development of DM and metabolic syndrome. Students having a WHR of more than 0.8 were categerosied as having high WHR. Cut-off values of WHR are not prescribed by WHO for children. But, previous studies have shown WHR values for children between 50th to 97th percentile are between 0.8–0.9, which is closer to the WHR cut-off values for adults as per WHO guidelines (14). This study shows that there are a high number of students with high waist – hip-ratio especially in girls. In comparison to girls with high WHR (83%), number of boys with higher WHR were less (68%). This shows that the physical activity levels are higher in boys. In the present study no significant correlation was found between WHR and pre-diabetic status (p value > 0.05). As overweight condition and obesity are risk factors for diabetes, a high waist measurement and a high WHR might serve as a good indicator in recognizing cases at high risk who might progress to pre-diabetic state and later Diabetes mellitus. Hence, follow up studies of such individuals with high WHR would be beneficial to identify the subjects who if at all, progress to the prediabetic stage so that diabetes maybe prevented.

In the present study subjects with higher BMI were in the euglycemic state and subjects with high FBS (>100 mg/dl) were found to be in the normal BMI range. No correlation was found between pre-diabetes with overweight or obesity. This might be due to the fact that insulin resistance is a common feature even in non-obese Asian Indian subjects with a specific “Asian Indian Phenotype” that refers to certain unique

clinical and biochemical abnormalities in Indians which include increased insulin resistance, greater abdominal adiposity *i.e.*, higher waist circumference despite lower body mass index, lower adiponectin and higher high sensitive C-reactive protein levels. This phenotype makes Asian Indians more prone to diabetes and premature coronary artery disease. At least a part of this is due to genetic factors**.** This observation is also in accordance with the study done by Narayanappa et al (11, 12, 13). However, the primary driver of the epidemic of diabetes is the rapid epidemiological transition associated with changes in dietary patterns and decreased physical activity as evident from the higher prevalence of diabetes in the urban population which in recent times is also seen in rural areas.

In the present study, 10 (7.14%) students had pre-diabetes (FBS > 100 mg/dl) out of which, 6 (7.3%) were boys and 4 (6.89%) were girls. Genetic factors probably play a more important role in development of DM than other risk factors like indicators of overweight and obesity. In this study, no significant correlation was found between prediabetic status and family history of DM. The reason for not showing significant correlation might be due to the younger age of the parents of the subjects who have not manifested the disease (DM) clinically as marriages taking place at very young ages are prevalent in rural setup from where the study subjects have been selected. As it is well established that DM manifestation starts usually after 40 years of age, in the present study many parents of the participants being below 40 years of age have either not manifested the symptoms of the disease or have not undergone screening tests due to lack of awareness. Follow up studies are necessary to understand the correlation between pre-diabetic state and family history of DM in these subjects.

Conclusion

Using simple screening methods in younger ages itself like measuring BMI, WHR and FBS, it is possible to identify individuals at high risk at an early age and accordingly lifestyle modifications can be adopted to postpone the onset of the disease and reduce the burden on the community and the nation. FBS measurement by glucometer is more convenient and less time consuming than routine lab testing as the equipment is portable. However, glucometer readings may not be appropriate to make a diagnosis of prediabetes accurately with a single reading and may show variations with lab reports which is a limitation of the present study. Hence, along with FBS values taken by glucometer, standard lab methods for testing the sample for FBS might give a more accurate result to reduce the error.

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