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Assessing Risk and High Risk for Type 2 Diabetes Using Indian Diabetes Risk Score among Adults of Bengaluru: An Observation from A Sector Based Survey Study Conducted in Bengaluru

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ABSTRACT

Aim of the study: To apprehend the incidence of pre-diabetes and high risk for Type 2 diabetes mellitus (T2DM) among adults of Bengaluru, South-India.

Materials and method: Six week's house hold sector based survey (N=307; 23-70 years), was conducted in City armed reserve police quarters, Chamrajpet, Bengaluru, Mysore road. Fasting and postprandial blood glucose levels were checked using Hemocue 201^+ blood glucose monitor device. In addition, body weight and body mass index were assessed. Categorization of screened subjects based on the risk for T2DM was done using Indian Diabetes Risk Score (IDRS) screening form. Of a total 1250 residents, almost one-fourth of them (n-307) had taken part in the survey.

Results: Study resulted in identifying people with normal glucose tolerance or non-diabetes (n=178), impaired fasting glucose or pre-diabetes (n=75), and T2DM (n=49) and newly diagnosed diabetes (n=5). Although, among the screened, the incidence of pre-diabetes was accounted for 24%, with one-half (n=37, 49%) of them found at high risk for type 2 diabetes. Age and gender matched data obtained from the screening postulated higher body mass index (BMI) ($p<0.001$) and waist circumference ($p<0.001$) as most contributing factors increasing the incidence of high risk for T2DM among the study population.

Conclusion: This survey manifested a higher incidence of pre-diabetes and high risk for T2DM among the study population, which is linked to the anthropometric measures.

Key words: High risk for Type 2 Diabetes Mellitus; Pre-diabetes; Body Mass Index; Waist circumference

INTRODUCTION

The incidence and prevalence of type 2 diabetes and prediabetes is increasing worldwide[1] and is found closely associated with industrialization, modernization and socioeconomic factors.[2] Reports also highlight that along with growing incidence and prevalence, cost expenditure of diabetes care is also high[3] which emphasizes the need for early detection and adopting appropriate therapies for prevention and effective management of type 2 diabetes mellitus. Few known reasons for such a huge rise in the prevalence is stipulated as low health awareness or ignorance, sedentary life style,[4] abnormalities in the metabolism of carbohydrates, fats and protein, inadequate or impaired secretion[5] and utilization of insulin.[6] In association with the rise in the prevalence, need for regular blood glucose monitoring for early detection of risk for diabetes, the phase also known as prediabetes,[7] characterized by impaired fasting glucose, is inevitable.

Madras Diabetes Research Foundation (MDRF), Chennai had developed Indian Diabetes Risk score (IDRS)[8] as a screening tool to identify the risk for diabetes. Studies have been done using IDRS as a simple,[9] non-expensive screening tool comprising of 4 different parameters age, family history, physical activity[10] and abdominal obesity and the current study used IDRS as a screening tool to categorize the screened subjects based on risk for T2DM.[11] Conclusive evidences suggest that physical inactivity <150 minutes/ week[12] subject an individual to higher anthropometric measures which is a leading cause for metabolic disorders like prediabetes with progressive loss of beta cell activity leading to impaired secretion of insulin,[13] insulin resistance resulting in the onset of T2DM.[14] Dietary changes,[15] sedentary behavior, abdominal obesity[16] and overweight[17] are highest known triggers resulting in inflated incidence and prevalence of prediabetes[18] and T2DM[19] and we used a demographic data sheet involving all these factors to assess the role of the said factors in the incidence of prediabetes and high risk for T2DM.

Cross sectional study reports a higher prevalence of prediabetes than T2DM[20] narrowing down the need for such studies exclusively in Southern states of India[21], postulating a need for early detection among Indians, specially among South Indians, to adopt appropriate measures to delay the onset of T2DM. Moreover, 50% of adults with prediabetes[22] and a few percentage even with symptoms of Type 2 Diabetes in India remain unaware[23] and get detected with complications at the time of diagnosis, which extrapolates the importance of early detection through periodic large scale screening. Keeping the above mentioned factors in the background, the present study was conducted to estimate the incidence of prediabetes and the prevailing factors resulting in risk for T2DM among adults of Bengaluru.

MATERIALS AND METHODS

The total population of the quarters included 1,250 police personals and family members excluding minors. Among which, one-fourth of them had volunteered to take part in the survey and who found fitting into the set inclusion exclusion criteria ever (N= 307, aged range: 23 and 60 years, with an average age of 41.5 ± 11.2 years) (Figure 1) were screened. The sampling technique used was Quota sampling.

Data collection

Inclusion and Exclusion criteria

Male and female adults who are residents of the police quarters for more than 10 years, willing to take part in the survey were included. People who were below 18 and above 70 years of age, physically and mentally challenged, with a history of systemic disorders, diabetes complications, handicapped or amputated, Physically inactive, frequently on night shifts, known alcoholics and consuming more than 5 servings of beverages a day were excluded from the survey. The study protocol was approved by Institutional Ethical Committee of S-VYASA (Deemed-to-be-University) and signed informed consent was sought before the data collection.

Assessments

The assessments included glycemic parameters like Fasting and post prandial capillary blood glucose, anthropometric measures like Body weight, height, Body mass index and waist circumference. Glycemic parameters were checked on Hemocue glucose 201^{+} glucose monitoring internally powered equipment 6VDC, catalogue # 1221142161, Sweden). Cuvette boxes were carried by the researchers in ice packs and were opened and used only when the subject indicated that he/she is ready for it, to ensure quality of the Cuvette and to avoid quantitative errors. Risk for diabetes was examined using IDRS: 0-29 low risk; 30-59 medium risk; >60 high risk for T2DM. In addition, demographic data sheet DDS) comprising of information like age, gender, house number, lane, race, duration of stay in the quarters, how many members being with diabetes and known prediabetes, mode and duration of physical activity, diet pattern and preference, sleep quality, and willingness to take part in such surveys if conducted ahead were filled by the eligible subjects.

Residents were informed about the survey two weeks in prior through flyer and pamphlets, and the need to be on empty stomach for Capillary Fasting Blood Glucose (CFBG) reading and tentative date and day of data collection upon each of the 18 sectors. In addition, a reminder was given by the researchers through sector wise home visit on a day prior to the data collection. The timing of screening was 6:30 am to 10:30 am on all the days. CFBG was tested after 8-12 hours of overnight fasting and Capillary post prandial blood glucose (however, identifying pre-diabetes was only based on CFBG) was checked within one and a half to two hours of breakfast.

Screening process

The interested volunteers were also asked to fill up Demographic Data Sheet (DDS) which included questions like the individual's age, gender, house and lane number, pattern of diet, job, job timings, stress, physical activity (PA), preferred mode of indoor and outdoor activity, duration of PA, health awareness, self-updating with health checkups, sleep, intake of coffee, tea, soft drinks, alcohol and smoking. IDRS screening form was distributed and except for waist circumference and height, subjects filled all other questions by self during their wait to get the fasting blood glucose check done. Prediabetes subjects were identified based on FBG (100 to 125 mg/dl) only.

Ethical clearance and informed consent

Ethical approval was sought from S-VYASA's ethical committee and all the rules were followed before, during and post the data collection (coding the data). Data was not collected from the volunteers who denied to sign the consent.

Data analysis

Screening was conducted over a period of six weeks. Data obtained from the survey was entered in Microsoft excel. Descriptive statistics was performed on continuous variables and responses of the screened subjects on IDRS and demographic data sheet were analyzed with logistic and linear regression method on Statistical package for the Social Sciences (Chicago, SPSS Inc.) for Windows, version 23.0.

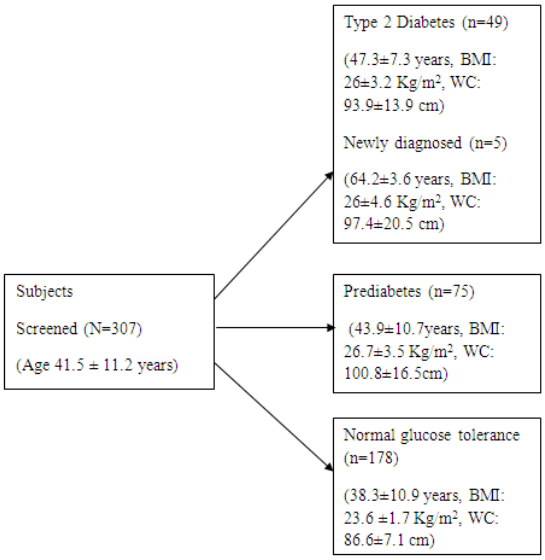

Figure 1: Flow chart

RESULTS

Baseline characteristics

Screening resulted in identifying 3 groups based on the glucose tolerance and intolerance. Group 1 comprised of people with impaired glucose tolerance/ T2DM (CFBG: 174.4± 43.9mg/dl; CPPBG 216.9± 55.4mg/dl) among which a few were newly diagnosed as Type 2 diabetes (n=5; CFBG 178.4±37 mg/dl; CPPBG 226.2±58.1 mg/dl) (Table 2). Group 2 consisted of one-fourth of the total screened subjects who were found with impaired fasting glucose/ prediabetes (n=75, CFBG: 113.1±6.7mg/dl) among which except for two all others were newly diagnosed. More than half of the subjects who belonged to Group 3, were found with normal glucose tolerance (n=178; CFBG 84.3±8.5mg/dl; CPPBG 111±20.9mg/dl). Demographic data showed more or less same range of age among the subjects of three groups (Table 1). Furthermore, the incidence of prediabetes is estimated as 24%, with an equal distribution across the gender. However, almost half of the total prediabetes (n= 37, 27%) were identified at high risk for T2DM as assessed by IDRS. On the other hand, the incidence of type 2 diabetes was estimated as 9.3% (n=5) (Table 2).

Parameters	Group 1	Group 2	Group 3
	54 (18)	75 (24)	178 (58)
Age (in years)	48.8±8.6	43.9±11.1	38.1±11.7
Male	33 (20)	40 (24)	91 (56)
Female	21 (15)	35 (24)	87 (61)

Table 1: Data either represented as number of samples (percentage) or as mean ± standard deviation; Demographic, anthropometric and glycemic parameters of the subjects categorized into three groups according to capillary fasting blood glucose (CFBG) range; Group 1: Type Diabetes; Group 2: Prediabetes and Group 3: Normoglycemia.

Risk according to Indian Diabetes Risk Score	Group 1	Group 2	Group 3
High Risk	29 (21)	37 (27)	71 (52)
Medium Risk	24 (18)	30 (23)	77 (59)
Low Risk	1 (2.5)	8 (20.5)	30 (77)
IDRS factors			
Age (<30 Years)	4 (4)	20 (20)	78 (76)
Age(30-50 years)	22 (17)	30 (23)	80 (61)
Age (<50 Years)	28 (39)	25 (34)	20 (27)
Vigorously active	1 (6)	6 (35)	10 (59)
Moderately active	48 (19)	54 (22)	148 (59)
Physically underactive	13 (22)	15 (28)	20 (50)
Waist circumference (WC)	18 (15)	16 (13)	86 (72)
WC	25 (23)	26 (24)	59 (53)
WC	11 (14)	33 (43)	33 (43)
No family history of T2DM	38 (19)	61 (30)	105 (51)
One parent with T2DM	13 (19)	10 (14)	47 (67)
Two parents are with T2DM	3 (9)	4 (12)	26 (79)

Table 2: Data represented as sample size (percentage); Categorization of subjects in terms of number of subjects and in bracket percentage distribution in each category according to the scores obtained from Indian Diabetes Risk score (IDRS); WC- Waist circumference, T2DM- Type 2 Diabetes Mellitus, IDRS- Indian Diabetes risk score.

Regression results

Linear regression assessment across the groups manifested all the assessed factors with high statistical significance, although, detailed interim analysis denoted, the most contributing factors increasing the incidence of prediabetes and high risk for T2DM as waist circumference and BMI (Table 3). Age as an assessment factors was also found with high statistical significance, even though, as the survey included negligible number of elderly adults, the significance level was not to be considered.

Parameters	Adjusted R^2	RMSE	Power (95% CI)	t value	F value	p value
CFBG	0.718	0.409	0.93 (4.083-4.355)	61.084	779.84	<0.001
CPPBG	0.507	0.541	0.91 (3.699-4.046)	43.912	316.08	<0.001
BMI	0.155	0.709	0.91 (4.341-5.716)	14.39	57.181	<0.001
Waist Circumference	0.106	0.729	0.89 (3.617-4.787)	14.145	37.369	<0.001
Age	0.135	0.617	0.73 (2.651-2.92)	10.754	48.591	<0.001

Table 3: Linear regression model with group 2 as Dependent variable; CFBG- Capillary Fasting blood Glucose, CPPBG- Capillary post prandial blood Glucose, BMI- Body Mass Index

Identified risk factors

Further statistical assessments confirmed waist circumference as the factor of risk, increasing the incidence of prediabetes among the study population (Table 4). In addition to that, two non-modifiable factors age and family history were also strongly imparting the role in surging risk for T2DM. Interestingly, physical activity as one of the modifiable factors, denoted as not considerably contributing (Table 4).

IDRS factors	Adjusted R^2	RMSE	Power (95% CI)	t value	F value	Linear regression significance (p value)	X^2	Chi-square significance (p value)
Age	0.135	0.717	0.93 (2.651 -2.92)	40.754	48.591	<0.001	50.75	<0.001
Physical Activity	-0.002	0.772	0.81 (2.198 - 2.813)	16.021	0.458	0.499	7.226	0.124
Family History	0.24	0.762	0.75 (2.218 - 2.423)	44.522	8.368	0.004	15.04	0.005
WC	0.36	0.857	0.94 (2.444 - 2.696)	45.201	12.45	<0.001	29	<0.001
Total IDRS	0.051	0.751	0.81 (2.633 -3.1)	24.167	17.486	<0.001	21.07	0.006

Table 4: Linear regression and Chi-square (X^2) test results of IDRS factors among group 2; WC= Waist circumference

Logistic regression results

Sensitivity of IDRS in identifying risk among people with diabetes is found to be 0.788 whereas the specificity is 0.333 with a false positive score of 0.667 with low area under ROC curve (AUC) score of 0.673 (p=0.13. X^2= 7.12). Whereas in case of prediabetes, the sensitivity of the tool was 0.571 with considerably high specificity of 0.8 with low false positive score of 0.2, with a fair AUC score of 0.7 and a statistical significance observed through p value (p=0.02, X^2= 11.093). When checked for people with normal glycemic status, the tool showed a sensitivity of 0.46, specificity of 0.7 with a false positive score of 0.29, showing an accuracy of 0.6 indicated by

AUC (p=0.404, X^2= 10.422). The results summarize that IDRS is identifying the people with prediabetes with the match found with the group formed based on fasting blood glucose reading, whereas not with people who are with Type 2 diabetes and normoglycemia.

Correlation results

Correlation analysis on total IDRS showed a strong positive correlation with CFBG (r=0.786, p<0.001) cross verifying the grouping of screened subjects based on glycemic parameters. Strong positive co-relation was even found with parameters like age in years with IDRS risk score weighted on age (r=0.9, p<0.001), BMI with Waist Circumference (WC) (r=0.73, p<0.001) and WC scores according to IDRS (r=0.529, p<0.001), and WC according to IDRS with total score of IDRS (r=0.682, p<0.001).

DISCUSSION

This survey was conducted with an aim to assess the incidence of prediabetes and high risk for type 2 diabetes among adults of South India. Secondary objectives of the study were to identify the factors increasing the risk for diabetes and incidence of prediabetes among the study population. The results of the study substantially exhibited body mass index and waist circumference as highest contributors increasing the incidence of prediabetes, whereas the non-modifiable factor like age and family history were also found equally significant on a wider view.

Logistic regression conducted on the data of this study statistically evaluated the accuracy of IDRS as a screening tool in identifying risk in terms of sensitivity, which indicates the true positive outcome of the data, confirmation of made through the scores of Area of ROC curve (AUC) as low in rightly identifying the risk among group 1 and 3. True negative outcome of the data as shown by the specificity scores and false positive scores are calculated by applying a formula one minus specificity. Confirmation of the result outputs are sought from F and H measures which are based on harmonic mean of precision and recall scores. Study published in 2019 supports the same.[24]

Study published in 2020 shows the prevalence of diabetes is 13.2% and that of prediabetes as 15.5%.[25] Whereas, the present study reports the incidence of prediabetes as 27%, and that of the undiagnosed type 2 diabetes as 9.3%, among adults of Bengaluru. This survey outcome thus plights the need for verifying the score distribution towards the factors of IDRS and points out a need for verifying the risk assessments with additional tools along with IDRS.

The study is of high social relevance as it could find high risk for incidence of prediabetes among adults of Bengaluru, one of the states in South India. To summarize, this study projects the need for further large scale survey studies to get an estimate of incidence of prediabetes and high risk for diabetes across different states of South India.

CONCLUSION

This study orients on the increasing incidence of prediabetes and undiagnosed type 2 diabetes among adults of South India and projects the need for large scale screening involving appropriate screening methods to identify the risk factors too. As this study assessed Body mass index and waist circumference, in addition to the non-modifiable factors like family history and age, as most prevailing risk factors further studies should aim at finding other factors as well. The result of this study also highlights the need for awareness programs through interventional

studies and to adopt therapeutic ways to manage anthropometric measures helping attain euglycemia, with which, the increasing incidence of prediabetes and Type 2 diabetes can be halted.

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CONFLICT OF INTEREST

None of the authors have any conflict of interest

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