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CONTEMPORARY EVALUATION OF INCIDENCE OF PREDIABETES AND HIGH RISK FOR TYPE 2 DIABETES MELLITUS AMONG ADULTS OF CHENNAI: ACROSS SECTIONAL STUDY

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ABSTRACT

Background: In addition to the surge in the incidence and prevalence of type 2 diabetes mellitus (T2DM), an increase in the incidence of prediabetes among young and middle-aged adults is also documented in developing countries like India. With this fact as the background the current study was conducted in Chennai.

Methods: This survey study was conducted in Aravind yoga and Naturopathy clinicpart of Chennai (N-230 adults; 32.9±9.6 years), India. Based on Capillary fasting blood glucose (CFBG) subjects were grouped into non-diabetes (n=108), prediabetes (n=92) and T2DM (n=30). Demographic data sheet (DDS) was used to assess the origin, education, socio-economic status and habit of the respondents and Indian Diabetes Risk Score (IDRS) screening form to detect the risk for T2DM.

Results: Approximately half of the screened subjects were newly diagnosed with prediabetes, among which one-ninth of them were (n=9; 9.8%) identified with high risk for T2DM. Statistical assessment manifested female subjects at higher risk based on low physical activity and higher waist circumference as compared to the male. Substantially, risk identification with IDRS was in line with the expedited results of CFBG among prediabetes.

Conclusion: Incidence of prediabetes among adults of Chennai is found escalating. Matched with the data obtained from DDS, the current study identified diet, physical inactivity and higher waist circumference as most contributing factors increasing incidence of high risk for T2DM among females and more or less the same factors in male as well.

Key words: Prediabetes, IDRS, Gender, Diet, Physical activity, Waist circumference

INTRODUCTION

Compared to the previous decades, prevalence of endocrine-metabolic disorders such as prediabetes and type 2 diabetes mellitus (T2DM) is seeing rise among young and middle aged

adults in developing countries[1]. Irrespective of nationality, race, culture and family history, efforts to estimate up to date prevalence and incidence of prediabetes is found to be comprehensive with imparted uncontrollable triggers associated with industrialization and modernization[2]. Other etiological factors include ignoring periodic health check, physical inactivity[3], sedentary life style, dietary habits and resultant abdominal obesity[4]. All these, in one way or other way lead to abnormalities in the metabolism of carbohydrates[5], fats and protein consequently leading to dysregulated insulin secretion (beta cell dysfunction) or utilization (insulin resistance), hallmarking prediabetes and T2DM.

Recent data shows young generation of developing countries getting diagnosed with T2DM, with most of these cases also report a possible prolonged period of unnoticed prediabetes[6]. Moreover, last three to four years statistics report a hike in the conversion of prediabetes to T2DM in Southern states of India with an estimated prevalence of 20% in Urban and 10% in rural side[7]. But, either lack of interest or ignoring the warning signs among the susceptible even let the health sectors go helpless in timely identification of those under risk, thereby increasing the incidence of prediabetes and type 2 diabetes, indirectly or directly hiking the incidence and prevalence. Indian Diabetes Risk Score (IDRS) is one of the commonly used screening tool to detect the risk for T2DM[8]. Literature search showed only one observational study, conducted in 2016, in Gujarat[9]. Hence conducting further studied in the state was essential where the population is basically fond of sweet taste. Along with identifying the incidence, this study also hypothesized female as more prone for T2DM than male, as well as to identify the etiological factors resulting in the hike.

MATERIALS AND METHODS

Study Design: This cross-sectional observational study was conducted among adults of Ambattur and Avadi (N=230), in Chennai. Sampling method employed for the screening process is voluntary response non-probability sampling.

Ethics: The study was a part of a randomized control trial aiming at identifying and recruiting prediabetes for a yoga-based mechanism of action study. Signed informed consent was obtained from the volunteers before data acquisition.

Selection and description of Participants: Subjects were screened based on the inclusion criteria: male and female between the age 20 to 60 years, residing in Ambattur and avadi, Chennai for more than 10 years and consenting to get their capillary fasting blood glucose (CFBG) checked.

Those who are physically and mentally challenged and/or with a history of systemic disorders, overweight or obese (BMI>30 kg/m^2), diagnosed with T2DM for more than 5 years, people with diabetes related complications, and those who are on night shift works, alcoholics and/or consuming more than 4 servings of beverages (coffee, tea, soft drinks, and other sweetened drinks) a day were excluded from the survey. STROBE guidelines were followed during the planning, designing and data collection.

Assessments: The assessments included capillary fasting blood glucose (CFBG), anthropometric measures, Indian diabetes risk score screening from (IDRS) and Demographic data sheet (DDS). CFBG was checked after 12 hours overnight fasting on commercially available glucometer (Dr. Morepen glucometer device, model: GLUCO ONE BG-03 auto; Serial No: GB 1410042; 4* reliability). Based on the CFBG, screened subjects were grouped into group 1 (CFBG > 126mg/dl), group 2 (CFBG: 100-125 mg/dl) and group 3 (CFBG <100mg/dl). Categorization of people based on risk for T2DM, into low (0-29), medium(30-59) and high(60-100) for T2DM under each of the groups were done based on the total score of response marked by the respondents on 2 modifiable (waist circumference and physical activity) and 2 non modifiable factors (age and family history) of IDRS (total score: 100)[10]. Waist circumference was assessed using a standard measuring tape.

Statistics: Demographic data sheet was used to understand the diet pattern, age, gender, origin, habits, diabetes duration, known prediabetes and duration, diabetes complication and nature and duration of physical activity of the subjects. Entire screening was done in six weeks (9th September, to 24th October; 6:45 am to 8:30 am of all the days, including Saturdays, Sundays, and holidays.

Dropouts: Data was tabulated in Microsoft Excel and was subjected for basic analysis in excel. Further, logistic regression analysis was done in IBM SPSS statistical software version 23. However, few CFBG data of range 100-105 mg/dl (n=3) and samples with technical errors (n=2) displayed on the device were excluded from the analysis.

RESULTS

Demographic details:

Demographic data sought from the participants indicated that all the participants were of Indian Nationality, from same geographic area (Urban) with no cultural distinctiveness Instinctively, majority of the participants of the survey were post graduates (n=176; 76.5%), lower middle socio-economic status (n=192; 83.5%) and with a preference to sweet taste (n-192; 82.6%) (Table I). Also, majority of the subjects were under the age range of 20-29 years (n=131; 56.9%). Most of the obtained details were not found to be skewed.

Distribution of scores under each domain of IDRS:

Initially the screened volunteers (N=230; average age 32.9±9.6 years) were categorized into three groups based on their CFBG values: Group 1 comprised of people with type 2 diabetes mellitus (n=30; 180±60 mg/dl), Group 2 with newly diagnosed with prediabetes (n=92; 110±7 mg/dl) and Group 3 were people with normal glucose tolerance (n=108; 91±6mg/dl)). Each of these group constituents were further categorized into high (IDRS: 60-100), medium (IDRS:30-59) and low risk (IDRS: 0-29) for T2DM (Table II).

However, the representation of risk categories across the three groups was intuitive. In Group 1 (n=21; 70%), and group 3 (n=56; 51.9%) majority of subjects were found in medium risk category (Table II), while in group 2, the majority were belonging to low risk category (n=61; 66.3%).Although, overall assessment on group 2,estimated the prevalence of prediabetes among adults of Gujarat as 40%, among which almost $1/9^{th}$ of the subjects with prediabetes (n=9; 9.8%) were found with high risk for incidence of T2DM (Table II).

Modifiable factors:

Based on the waist circumference majority of subjects of group 1 were at medium risk category (n=16; 53.3%), whereas in group 2 (n=50; 54.3%), majority were at high risk for T2DM and in group 1 majority belonged to low-risk category (n=86; 79.6%). Although, in group 2 and 3, female subjects were found with high risk for T2DM with comparatively higher W.C, whereas among people of group 1, higher W.C among male participants were observed to have contributing higher towards risk for T2DM. On check for status of physical activity as another modifiable factor of significance in increasing risk for diabetes, majority of subjects of group 1 were found with medium risk (n=27; 90%), while among subjects of both group2 (n=43; 46.7%) and group 3 (n=46; 42.6%) majority were in moderate risk for T2DM (Table III). Above that, female subjects were

found to have higher risk for T2DM, being reportedly with low physical activity status when compared to male.

Non-modifiable factors:

Age, as one of the non-modifiable factors contributing towards increasing risk for T2DM, when taken into consideration, majority of subjects of group 1 (n=22; 72.3%) were found with medium risk, where on the other hand, subjects of group 2 (n=52; 56.5%) and group 3 (n=83; 76.9%) were with low risk for T2DM.Of all the 3 groups, compared to female, male subjects with higher age were found to have higher risk for T2DM. Among the total subjects screened, none were with a family history of both parents being with T2DM. In addition, the check for the distribution of subjects across groups resulted in identifying majority in group 1 (n=19; 63.3%), 2 (n=77; 83.7%) and 3 (n=92; 85.2%) being at low risk for T2DM. However, more of male subjects were reportedly with considerably high family history among the 3 groups.

Pearson's correlation test showed a positive association of CFBG with waist circumference (r=.439; *P<.001*) and overall IDRS score (r=.406; *P<.001*). Similarly, age of the subjects were also found positively correlated with total IDRS (r= .656; *P<.001*). Nonetheless, except for family history, all other factors of IDRS were strongly related to total IDRS score, indicating the applicability of the screening form on the population (Table IV). Moreover, exploratory factor analysis denoted physical activity and family history as most impactful factors interconnecting other assessed parameters and factors of IDRS checked in the current survey (X^2= 16.06; *P.042*) (Table V). Likewise, derived values of the study presumed the role of CFBG, age and waist circumference as major factors increasing incidence of high risk for T2DM. Also, among the subjects with high-risk for T2DM (n=9), females (n=8) were found to be dominant compared to male (n=1) (Table VI).

DISCUSSION

As known, the prevalence and incidence of prediabetes among youngsters is surging. Current multi-centric village based observational study conducted with an objective of estimating the prevalence of prediabetes and high risk for type 2 diabetes among adults of Chennai identified a higher prevalence of prediabetes among adults of Chennai, low physical activity and higher waist circumference as dominant factors. However, female subjects were found with utmost risk

compared to male, indicating the need for higher care and attention on glycemic and anthropometric measures among females than male.

Moreover, the sweet taste preference and consumption of high glycemic index items among the study population presumably corresponded to low activity status. And, these habits would have resulted in increased waist circumference, hiking risk for T2DM[11]. However, this study also witnessed post graduates and people of lower middle category socio economic status categorized with high risk, stating the study findings on glycemic and anthropometric measures as tallied to the demographic status of the individuals. Subsequently, higher stress, anxiety, changes in quality and quantity of diet and habits are probably the major triggers of the time, resulting in endocrine disharmony ending up adults in prediabetes[12].

Furthermore, witnessing the study outcomes, it is clear that all the four factors are more or less equally liable for the etiopathogenesis of high risk for T2DM, increasing the prevalence of prediabetes and T2DM and similar findings are already reported[13], although no recent studies are found reporting the same. Even though, amidst the pandemic, when stress and emotional upsurges are commonly reported complaints, early identification of the high-risk individuals in right time across different states of India, might help govern the hike in the prevalence of most common metabolic endocrine disorders like type 2 diabetes[14] and its asymptomatic risk phase named prediabetes and simultaneously getting to know the need for adopting therapeutic interventions with no delay.

Summing up, in search interfaces, prevalence based cross sectional and experimental studies are widely found reported from Southern parts of India like Karnataka[15] and Tamil Nadu. But the studies are also reportedly inconclusive with lack of statistical findings and observational studies from Western part of India are few. Hence this study adopted a better statistical approach for reporting the high prevalence of prediabetes among young and middle-aged adults of Gujarat. The finding was found aligned with factors like diet, waist circumference, lack of physical activity, and family history. Therefore, this study propagates the need for half yearly blood glucose check and organizing health education programs on diet and habit modification to achieve glucose homeostasis. Additionally, it is imperative to conduct large scale observational studies across other parts of Western India, to ensure early detection and adopting right measures to manage and prevent the onset of prediabetes and progression to type 2 diabetes mellitus.

Strength of the study:

The current study findings are robust with the statistical support. Also, the gender distribution is equal and female are found with higher risk than male, highlighting higher need for attention among female adults among state of Tamil Nadu. Study did not include elderly adults. Demographic details of the population showed almost similar pattern of taste preference, educational and socio-economic status among majority of the participants, which could let the researcher sum up the findings on encouraging better care among young and middle-aged adults.

Limitations of the Study

Capillary fasting blood glucose was the only glycemic variable checked. As majority of the volunteered subjects belonged to similar educational and socio-economic background, statistical assessment based on different demographic details was not conducted. Compared to the total population of Aravind yoga and naturopathy clinic, the current study sample size is considerably low.

CONCLUSION

The current study estimated a higher incidence of prediabetes among young and middle-aged adults of Chennai and the reason for which would be lack of physical activity, sweet preferred diet, and higher waist circumference in addition to the family history. However, large scale studies are to be conducted in order to assess the role of quality and quantity of diet, and other predominant risk factors, postulating higher incidence of prediabetes among females separately and on males as well, spiking the incidence for high risk for T2DM among population of Tamil Nadu.

RESULT TABLES

Age	20-29	30-39	40-49	50-69
	131(56.9)	20(8.7)	20(8.7)	59(25.7)
Socio economic status (SES)	Upper SES (2,70,000 INR/ annum)	Lower middle SES (70,000-2,70,00 INR/ annum)	Low SES (<70,000 INR/ annum)	Unsure/ Not willing to reveal
	34(14.8)	192(83.5)	4(1.7)	-
Education	Post Graduate	Graduate	Under Graduate	Not willing to reveal
	176(76.5)	42(18.3)	12(5.2)	-
Profession	Government job	White collar Job	Non-Government Job	Nil/ House hold work/ Not

				willing to reveal
	29(12.6)	4(1.7)	180(78.3)	17(7.4)
Taste preference	Sweet	Salty	Spicy	Nothing specific
	190(82.6)	10(4.3)	17(7.4)	13(5.7)

Table I. Demographic data

Group	Gender wise distribution n(%)	Mean Age (± SD) in years	Mean CFBG (±SD) in mg/Dl	Mean W.C (±SD) in centimetres	Risk according to IDRS		
					High risk n(%)	Medium risk n(%)	Low risk n(%)
Group 1	Female (n=13; 43.2)	36.8±7.5	186.5±63.3	85.5±6.2	2(15.4)	9(69.2)	2(15.4)
	Male (n=17; 56.7)	43.5±6.1	176.7±55.7	96.8±7.7	5(29.4)	12(70.6)	-
	Sub Total (n=30; 13)	54.7±16.2	179.9±59.6	91.9±8.9	7(23.3)	21(70)	2(6.7)
Group 2	Female (n=52; 56.5)	30.6±8.1	114.9±4.8	90.9±7.5	6(11.5)	28(53.4)	18(34.6)
	Male (n=40; 43.5)	30.6±8	114.7±4.7	101.2±8.1	2(5)	33(82.5)	5(12.5)
	Sub total (n=92; 40)	33.6±9.4	114.8±4.7	95.4±9.3	8(8.7)	23(25)	61(66.3)
Group 3	Female (n=47; 43.5)	29.2±7.6	92.3±4.8	76.6±6.2	2(4.3)	29(61.7)	16(34)
	Male (n=61; 56.5)	31.1±10	89.9±6.9	86.4±5.5	2(3.2)	27(44.3)	32(52.5)
	Sub Total (n=108; 47)	40.6 ±7.4	180.9±58.2	82.1±7.5	4(3.7)	56(51.9)	48(44.4)

Table II. Group and Gender based categorization of Glycemic, anthropometric and IDRS based parameters of risk for T2DM; CFBG- Capillary fasting blood glucose; SD- Standard deviation; %- percentage

IDRS paramete	Category	Group (n=30)	Male n (%)	Female n (%)	Group n=92)	Male n (%)	Female n (%)	Group (n=108)	Male n (%)	Female n (%)
Age	Low Risk (<30 years)	5(16.7)	1(20)	4(80)	52(56.5)	14(26.9)	38(73.1)	83(76.9)	46(55.4)	37(44.6)
	Medium risk (30-50 years)	22(73.3)	13(59.1)	9(40.9)	33(35.9)	20(60.6)	13(39.4)	17(15.7)	9(52.9)	8(47.1)

	High risk (<50 Years)	3(10)	3(100)	nil	7(7.6)	5(71.4)	2(28.6)	8(7.4)	6(75)	2(25)
Waist circumference (W.C) in centimeters)	Low risk (<80 cm)	4(13.1)	2(50)	2(50)	6(6.5)	3(50)	3(50)	86(79.6)	51(59.3)	35(40.7)
	Medium risk (80-89cm)	16(53.3)	9(56.2)	7(43.8)	36(39.1)	20(55.6)	16(44.4)	19(17.6)	9(47.4)	10(52.6)
	High risk (>90cm)	10(33.3)	6(60)	4(40)	50(54.3)	17(34)	33(66)	3(2.8)	1(33.3)	2(66.7)
Physical activity	Low risk (Very active)	2(6.7)	1(50)	1(50)	25(27.2)	8(32)	17(68)	28(25.9)	18(64.3)	10(35.7)
	Medium risk (Moderately active)	27(90)	16(59.3)	11(40.7)	43(46.7)	28(65.1)	15(34.9)	46(42.6)	30(65.2)	16(34.8)
	High risk (Under active)	1(3.3)	-	1(100)	24(26.1)	4(16.7)	20(83.3)	34(31.5)	13(38.2)	21(61.8)
Family history (FH)	Low risk (no FH)	19(63.3)	9(47.4)	10(52.6)	77(83.7)	31(40.3)	46(59.7)	92(85.2)	52(56.5)	40(43.5)
	Medium risk (one parent with diabetes)	11(36.7)	8(72.7)	3(27.3)	15(16.3)	9(60)	6(40)	16(14.8)	9(56.3)	7(43.7)

Table III. Distribution of risk score among three groups on modifiable (waist circumference and physical activity) and non-modifiable (age and family history) factors.

Components correlated		**Pearson's r**	**p value**	**Lower 95% CI**	**Upper 95% CI**
CFBG	W.C (IDRS)	0.439	< .001	0.328	0.538
CFBG	Total IDRS Score	0.406	< .001	0.292	0.509
Age	Total IDRS Score	0.656	< .001	0.576	0.724
W.C	Total IDRS Score	0.464	< .001	0.356	0.56
AGE (IDRS)	Total IDRS Score	0.672	< .001	0.594	0.737

W.C (IDRS)	Total IDRS Score	0.59	< .001	0.499	0.668
PA (IDRS)	Total IDRS Score	0.411	< .001	0.298	0.513

Table IV. Pearson's correlation output

Factors	**Uniqueness**	**df**	**Chi square value**	**Significance value (p)**
CFBG	.750	8	16.060	.042
Age	.153			
Waist circumference	.426			
IDRS components				
Age	.002			
Waist circumference	.005			
Physical activity	.956			
Family history	.900			

Table V. Exploratory factor analysis output; applied rotation method is Promax

Risk for T2DM among prediabetes	**Gender**	**FBS (in mg/dl)**	**Age (in years)**	**W.C (in cm)**
High risk	M(n=1); F(n=8)	116±3.7	44.2±8.5	100.8±7.4
Medium risk	M(n=34); F(n=26)	115.2±5	35.2±8.8	96.7±8.8
Low risk	M(n=5); F(n=18)	113.4±4.1	25.2±2.9	89.8±8.9

Table VI. Factors increasing risk for type 2 diabetes among prediabetes; M=Male; F=Female; W.C= Waist circumference

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