A Study of Glucose Tolerance Test, Body Mass Index and Waist Hip Ratio as a Marker of Pre-Diabetes

Vijayashree S. Gokhale a#, Ponvijaya M. Yadav a*, Rupesh Parati a≡, Dhiral R. Mahajan a≡ and Atiullah Malik aⱷ

a Department of Medicine, Dr. D. Y. Patil Medical College, Hospital & Research Centre, Dr. D. Y. Patil Vidyapeeth, Pune, India.

ABSTRACT

Background: India is becoming the “Diabetes Capital of the World”. Younger and younger individuals are being diagnosed with Diabetes. This study was planned to diagnose prediabetes in younger individuals having positive family history with aim of encouraging to develop lifestyle modifications to delay progression to Diabetes.

Aims: To study prediabetes in first degree relatives (FDR) of diabetic patients in the group of 30-45 years by glucose tolerance test (GTT), body mass index (BMI) and waist hip ratio (WHR).

Study Design: Cross sectional observational study.

Place and Duration of Study: Study was conducted at Department of general medicine, Dr D Y Patil Medical College, Pune 18 from July 2019-september 2021.

Methodology: This study conducted in a semi-urban Teaching Hospital in Maharashtra, India. 100 asymptomatic first-degree relatives (31 women, 69 men) age group 30-45 years, of diabetic patients were selected for study after informed consent. The study participants were clinically examined and subjected to OGTT (oral glucose tolerance test) and BMI, WHR were calculated.
Data analysis was done using SPSS (Statistical Package for Social Sciences) Software version 20. **Results:** In our study, out of 100 participants 61% study subjects were overweight having a BMI of 25-29.90 and 13% were obese. 65% subjects had raised Waist to hip ratio. 36 subjects had raised fasting Blood sugar level (BSL) and 40% had raised 2hr BSL on OGTT and incidence of diabetes and prediabetes were 14% and 26% respectively. **Conclusion:** Significant correlation of Prediabetes was seen with abnormal OGTT, Raised Fasting Blood glucose, raised BMI. We found higher incidence of Prediabetes in those with Maternal Diabetes.

**Keywords:** Prediabetes; OGTT; BMI; WHR.

### 1. INTRODUCTION

Diabetes Mellitus an endocrinological disorder of varied etiology, characterized by chronic hyperglycemia along with disturbed metabolism of fats, carbohydrates and proteins resulting either due to decreased insulin secretion, increased glucose production or decreased glucose utilization ultimately leading to multiorgan dysfunction [1]. Complex interplay of various environmental and genetic factors are involved in diabetes.

Pre diabetes is a concept wherein affected individual is neither normoglycemic nor has full-fledged diabetes. This dysglycemic state poses increased risk for acquiring diabetes mellitus as well as associated complications in near future if no preventable measures are undertaken. Studies have shown that the risk of progression of pre diabetes to diabetes is around 3.5- 7% per year.

National Urban Diabetes Survey reported the prevalence of pre diabetes in India is around 14% [2]. COVID 19 and pre diabetes has been a topic for research recently. Heidarpour M, Abhari A P, et al. [3] study from Iran had studied the correlation between pre diabetes and severity of COVID 19 infection from January 2020 to July 2021 and found that there is a possibility of worsening of COVID 19 symptoms in pre diabetic patients and early detection could help to adopt rigorous preventive measures for such individuals. Our study was done to identify pre diabetic individuals aged between 30-45 years who are FDR of diabetic patients by simple measures which included OGTT, BMI and WHR.

American Diabetes Association [4] has defined pre diabetes using OGTT as follows:

| Fasting Plasma Glucose 100 mg/dL (5.6 mmol/L) to 125 mg/dL (6.9 mmol/L) (Impaired Fasting Glucose) |
| OR 2-h Plasma Glucose during 75-g OGTT 140 mg/dL (7.8 mmol/L) to 199 mg/dL (11.0 mmol/L) (Impaired Glucose Tolerance) |

BMI calculated by standard metric formula: BMI = weight (kg) / [height (m)]^2

<table>
<thead>
<tr>
<th>BMI</th>
<th>Weight status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 18.5</td>
<td>Underweight</td>
</tr>
<tr>
<td>18.5-24.9</td>
<td>Normal weight</td>
</tr>
<tr>
<td>25.0-29.9</td>
<td>Overweight</td>
</tr>
<tr>
<td>30.0-34.9</td>
<td>Obesity class I</td>
</tr>
<tr>
<td>35.0-39.9</td>
<td>Obesity class II</td>
</tr>
<tr>
<td>Above 40</td>
<td>Obesity class III</td>
</tr>
</tbody>
</table>

**Chart 1. BMI calculation**

Waist Hip Ratio of < 0.85 in males and < 0.75 in females is considered as low risk.

### 2. MATERIALS AND METHODS

100 patients enrolled for study will be explained the procedure and the purpose of the study, informed consent will be taken from the patient. Details of history as demographic, personal, family history, and any significant past history were recorded in study proforma. Required physical examination and necessary investigations will be done.

Study subjects were asymptomatic children and other FDR, in age group 30-45 years of Type 2 Diabetic patients attending General Medicine OPD, Specialty Diabetes OPD (Outpatient Department) and Wards.
Study was conducted in a Medical college and Hospital in Maharashtra, India.

Period of study was from July 2019 to September 2021.

- To estimate the presence of prediabetes in FDR of diabetic patients by clinical examination
- To perform Oral glucose tolerance test
- Body mass index and Waist hip ratio will be calculated

2.1 Inclusion Criteria

First degree relatives (FDR) of diabetic patients in the age group of 30-45 years who are asymptomatic.

2.2 Exclusion Criteria

- First degree Relatives who are symptomatic for diabetes
- Those with co-morbidities like hypothyroidism, hyperthyroidism, dyslipidemia, Polycystic Ovarian Disorder, taking cortico-steroids, having any other acute illness for example any infectious diseases such malaria, dengue, typhoid etc.

2.3 Data Analysis

Data collected, and tabulated in Microsoft Excel in Master Chart. Analysis done using SPSS (Statistical Package for Social Sciences) Software version 20. Categorical variables expressed in terms of frequency and percentage and continuous variables in terms of mean and Standard Deviation. Association between risk factors and glucose tests were analyzed using chi square test. ANOVA test was applied to find any difference in mean value of study variables across OGTT group with p<0.05 as statistically significant value at 95% Confidence interval.

3. RESULTS AND DISCUSSION

The study shows more than half (52%) were having family history among mother and 9% have family history among both father and mother.

The study shows majority (61%) study subjects were overweight (BMI-25-29.90) and 13% were obese.

More the BMI value, increased is the risk for developing Pre diabetes. Central obesity is considered one of the risk factor for Prediabetes.

The study showed 36 % had raised fasting BSL (more than 100 mg/dl) and 40% had raised 2hr BSL (more than 140 mg/dl)

Our study showed that on the basis of OGTT 60 had normal blood sugar level. Incidence of diabetes was 14% and 26% were pre-diabetics.

The following table shows comparison of mean values of various study variables among OGTT status groups (normal, Pre-diabetic and diabetics). ANOVA test was applied to find any difference in mean value of study variables across OGTT group and we found that BMI, GTT 2hr, Fasting BSL had significant difference in mean values among three groups of OGTT Status.
Table 1. OGTT-Fasting, 2hr glucose test findings

<table>
<thead>
<tr>
<th>Blood Sugar Findings</th>
<th>Fasting BSL</th>
<th>2 Hour BSL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>64</td>
<td>60</td>
</tr>
<tr>
<td>Raised</td>
<td>36</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2. Oral Glucose Tolerance Test (OGTT) status

<table>
<thead>
<tr>
<th>Status</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Pre diabetes</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Diabetes</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Fig. 1. Family History of Diabetes among study subjects

Fig. 2. BMI distribution among study subjects
The aim of the present study is to diagnose prediabetes among the asymptomatic first degree relatives aged between 30–45 years of type 2 diabetic patients. As early detection of prediabetes will help us to adopt preventive measures at the earliest in the form of lifestyle changes and/or pharmacological interventions to prevent or delay the progression to diabetes.
In the present study, out of 100 subjects majority were in the age group of 30-35 years (37%) followed by in the age group of 36-40 years (36%), 27% were aged between 41-45 years. Mean age was 37.5±4.41 years. These findings were different as compared to the study conducted by Chandrupatla SG, et al. [5] using the National Family Health Survey India, 2015-2016 which had reported that the incidence of prediabetes (7.14%) was highest between 50-54 years followed by 35-49 years (6.63%). Results similar to our study was found in a study conducted by Aldossari K.K, et al. [6], in central Saudi Arabia involving participants aged 18-60 years and had reported that incidence of prediabetes was maximum in adults aged 25-44 years.

In the present study, maximum subjects were males (69%) as compared to females (31%) and out of 26 prediabetic patients, 69.2% were males and 30.8% were females. Similar results were reported in various other studies [7,8]. A study conducted by Vatcheyaa K.P, et al. [7] from the Cameron County Hispanic Cohort in Texas and reported that the prevalence of pre diabetes was higher among men as compared to women. Different results were found in various other studies [9,10,11] one of which is a study conducted by Jarvis FM [9] using data from a symposium hosted by the American University, Washington DC and reported that Impaired glucose tolerance was more prevalent among women as compared to men.

In our study, 46% subjects had moderate physical activity and 54% had sedentary lifestyle. Similar conclusions were reported in different studies [12,8,13,14], one of which is a study named MESA (Multi-ethnic study of atherosclerosis) conducted by Joseph J.J, Echouffo-Tcheugui J.B, et al. [12] that the incidence of diabetes was inversely proportional to exercise, vigorous physical activity and directly related to sedentary lifestyle.

In our study more than half (52%) were having family history among mother, 39% had among father and 9% have family history among both father and mother. Out of 26 prediabetics 17 (65.4%) were having family history of diabetes in mother, 7 (26.9%) were having family history of diabetes in father and 2 (7.7%) were having family history of diabetes in both parents. There are many studies giving importance to maternal history of diabetes [15,16,17,18,19,20] one of which is a study conducted by Papazafiropoulou AK, Papanas N et al. [21] that the likelihood of Type 2 Diabetes Mellitus (T2DM) in the next generation is higher in presence of maternal diabetes than paternal. Different results [22,23] giving importance to paternal history of diabetes are reported one of which is a study from Maharashtra conducted by Deshmukh JK, Mulay PY et al. [22] involving 1020 subjects coming to outpatient departments for medical health check-ups and among those diagnosed with pre diabetes, 7% 9% and 1% had mother, father and both parents as diabetic respectively.

In our study, 82% study participants had mixed diet and 18% had plant based dietary intake which includes vegetables, dairy products, legumes etc. 12% subjects gave history of smoking and 26% were alcoholics. Similar results [24,25] were reported in a study conducted by Quin F et al. [24] from Boston, Massachusetts that western type of food pattern which included red meat, sea foods, fast foods etc. had contributed to increased risk of diabetes and an inverse relationship was found between grain-vegetable foods and the incidence of pre diabetes.

Various studies [26,27] giving importance to prevalence of diabetes and history of smoking and alcohol consumption are reported one of which is a study conducted by Subramani S.K, Yadav D, Mishra M, [26] in Gwalior, India found that the prevalence of diabetes was 9.6% and 10.8% in populations who have the habit of smoking and alcohol consumption respectively.

In our study, related to BMI 61% study subjects were overweight (BMI=25-29.90) and 13% were obese and there was significant difference in BMI of Impaired Glucose Tolerance Test (IGTT) groups and out of 26 pre-diabetics, 23 (88.5%) were overweight, and 3 (11.5%) were obese. Similar results were reported in various other studies conducted [22,23,28].

In our study, out of 26 pre-diabetics 18 (69.2%) had raised WHR. Similar results were seen in a study conducted by Bala M, Meenakshi et al. [29] in Pt. B. D. Sharma PGIMS, Rohtak, consisting of 30 prediabetic cases found that 90% had raised WHR and 10% had normal WHR. Another study conducted by Shah A, Bhandary S et al. [30] in Kavre district of Nepal consisting of 100 study subjects attending the Kathmandu University Teaching Hospital had reported that risk of diabetes was high when the WHR in male and female are more than 1.00 and 0.94 respectively.
Our study found that on OGTT among asymptomatic FDR incidence of diabetes was 14% and 26% were pre-diabetics. We also found that 36 subjects had raised fasting blood glucose and 40 had raised 2-hour blood glucose on OGTT. A study conducted by Feizi A, et al. [31] from Iran included 766 first degree relatives of diabetic patients, initially they had normal OGTT values later were followed up for 7 years and found that 23 subjects (3%) developed diabetes, 118 subjects (29.3%) had Impaired Fasting Glucose, 81 (11.5%) Impaired Glucose Test and rest continued to have Normal Glucose values.

4. CONCLUSION

In Our study Abnormal OGTT, Raised Fasting Blood glucose and raised BMI did correlate with Prediabetes. All our patients had Family history of Diabetes, but we found higher incidence of Prediabetes in those subjects with Maternal Diabetes.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

All authors have declared that "Written informed consent were taken from all study subject".

ETHICAL APPROVAL

All authors hereby declare that the study was approved by the Institutional ethics sub-committee of Dr. D. Y. Patil Medical College, Hospital & Research Centre, Pimpri (I.E.S.C. /135/2019)

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

10. Dasappa H, Fathima FN, Prabhakar R, Sarin S, Prevalence of diabetes and prediabetes and assessments of their risk factors in urban slums of Bangalore, J


© 2021 Gokhale et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here: https://www.sdiarticle5.com/review-history/81353