

## ORIGINAL ARTICLE

# Prevalence of Pre-diabetes and its associated risk factors: A cross-sectional study in West Tripura district of India

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## Abstract

**Background:** Early detection of Pre-diabetes and controlling the risk factors may delay the development of Diabetes and related complications. **Objectives:** To estimate the prevalence of Pre-diabetes in West Tripura district of India and to study its associations with selected risk factors. **Methods:** This community based cross-sectional study was conducted in West Tripura district of India, during 1<sup>st</sup> January 2018 to 31<sup>st</sup> December 2019 among 320 individuals selected by multistage sampling. Fasting blood sugar was tested for diagnosing Pre-diabetes. Data entry and analysis were performed using SPSS-24. **Result:** Prevalence of Pre-diabetes in West Tripura district was 19.4%, 28.1% were hypertensive and 32.5% had high BMI. Multivariable logistic regression has identified age  $\geq 40$  yr (OR: 20.62, 95% CI: 4.97 – 85.49) higher socioeconomic status (OR: 4.99, 95% CI: 1.95 – 12.72), family history of diabetes (OR: 9.72, 95% CI: 2.51 – 37.61), higher BMI (OR: 2.79, 95% CI: 1.32 – 5.89) and physical inactivity (OR: 3.52, 95% CI: 1.66 – 7.46) as the predictors of Pre-diabetes. **Conclusion:** West Tripura district of India has higher prevalence of pre-diabetes than the national average. Age  $\geq 40$  yr, higher socioeconomic status, family history of diabetes, higher BMI and physical inactivity were identified as significant predictors of Pre-diabetes in this region.

## Keywords

Pre-diabetes; Risk factors; West Tripura

## Introduction

Diabetes mellitus is a group of metabolic disorders characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both.(1) Pre-diabetes is a condition that comes before diabetes, with no specific symptoms, characterized by blood glucose levels higher than normal but not high enough to be called diabetes.(2) The term 'pre-diabetes' was coined by the 'American Diabetes Association' and the same clinical condition is termed as 'intermediate hyperglycaemia' by the

WHO. According to WHO, intermediate hyperglycaemia relates to two distinct states, impaired fasting glucose (IFG) defined as fasting plasma glucose of 110 mg/dl to 125 mg/dl and impaired glucose tolerance (IGT) defined as post-load plasma glucose of 140 mg/dl to 200 mg/dl or a combination of both.(3)

The number of people living with diabetes and pre-diabetes has increased worldwide. In 2019, worldwide 373.9 million adults are estimated to have IGT and the number will increase to 548.4 million by

2045.(4) In Southeast Asia, the estimated prevalence of IGT was 7.7% which may rise up to 8% by the year 2045.(4) In India, around 25 million individuals are living with pre-diabetes in 2019 and the number is expected to increase to 41 million by 2045.(4)

Pre-diabetes increase the risk of developing overt type 2 diabetes to 3 to 7 fold compared with normoglycaemic individuals.(5) People with prediabetes may have concomitant damage to end organs, such as eyes, kidneys, blood vessels and the heart that are traditionally considered to be complications of diabetes.(6,7,8)The risk factors for pre-diabetes are similar to the risk factors for diabetes like age, obesity, family history, lack of physical activity etc, and some of them are modifiable.(9,10,11)Several clinical trials demonstrated that lifestyle or pharmacologic interventions at populations having prediabetes would prevent or delay the development of diabetes.(12,13,14)

Tripura is a small north eastern state of India having population of various ethnic origins with different lifestyles. According to ICMR, it has the highest prevalence of diabetes (9.4%) and pre-diabetes (14.7%) among all the north eastern states.(15)Despite high burden of Pre-diabetes, only limited data are available regarding Pre-diabetes and its associated risk factors in this state. In this context this study was designed to assess the magnitude of Pre-diabetes and factors associated with it among the general population of West Tripura district of India.

### Aims & Objectives

1. To estimate the prevalence of Pre-diabetes among general population of West Tripura district of India.
2. To study the associations of some selected factors with Pre-diabetes in this population.

### Material & Methods

**Study Type:** Community based Cross-sectional study.

**Study Area:** West Tripura district of India.

**Study Population:** Subjects aged 18 yr and above.

**Study Duration:** 1st January 2018 to 31st December 2019.

**Sample Size calculation:** Minimum sample size requirement for this study was determined to be 320 subjects, using the formula  $(4 \times p \times q) \div L^2$  at 5% level of significance, tolerating 4% absolute error and using a

pre-determined prevalence of pre-diabetes as 14.7% estimated by a published study.(15)

**Sampling technique:** Multistage sampling technique was followed. [Figure 1], sampling algorithm) West Tripura District has got 2 urban municipal areas (Namely Agartala Municipal Corporation area and Ranirbazar Municipality) and 9 rural blocks. Agartala Municipal Corporation (AMC) was further subdivided in four zones. Approximately 40% population of the district were urban inhabitant and rest 60% were rural inhabitant and among the urban population 3% were residing in Ranirbazar municipal area.(16) To ensure proportionate representation in the study sample, 128 from urban (124 from AMC area and 4 from Ranirbazar municipal area) and 192 subjects from the rural areas were included. At the 1st stage, one municipal ward from each of the 4 zones of AMC, one ward from Ranirbazar municipal area and one Gram Panchayets (GP) from each rural block was chosen by simple random sampling (SRS). In the 2nd stage, families were selected from the identified urban wards and gram panchayets by SRS without replacement and for this the family registers was used as sampling frames. Presuming equal population in each of the AMC ward and GP, 31 families from each of the selected wards of AMC and 21 families from each of the selected GPs were chosen. At the final stage only one eligible adult member from each of these identified families was chosen by SRS.

**Exclusion Criteria:** Subjects with previous history of Diabetes, pregnant or lactating women and very sick or mentally unsound subjects were excluded from this study.

**Working Definition:** Subjects having fasting blood sugar (FBS) value of  $\geq 126$  mg/dl were considered as diabetic and FBS value of 110 mg/dl to 125 mg/dl were considered as either IFG or Pre-diabetics.

**Consent:** Written informed consent was obtained from all the study subjects before enrollment.

**Strategy for data collection:** Data were collected by paying home visits to the selected houses and using a validated and pre-tested interview schedule. On the first day of visit study participants were explained about the study and asked to remain fasting for at least eight hours on the next morning, when fasting blood glucose values were measured using a glucometer (Accu-Check active blood glucose monitor, Roche diagnostics, Germany). Measurement of blood pressure, height, weight, waist and hip circumference, tobacco and

alcohol consumption including calibration of the measuring instruments were performed as per the techniques adopted from WHO MONICA study. (17)

**Data analysis & software:** Data entry and analysis were performed using SPSS for windows, version - 24. Data were presented with the help of text, tables, charts, etc. Qualitative data were expressed in terms of proportions and continuous data were expressed in terms of mean and standard deviation. Chi-square test for testing the significance of difference between two or more proportions and student t – test for testing the significance of difference between two means were used. Binary logistic regression analysis was performed to find out the predictors of Pre-diabetes. P-value < 0.05 was considered as statistically significant.

**Ethical approval:** This study was approved by the Institutional Ethics Committee of Agartala Government Medical College. Subjects identified as either Pre-diabetic or Diabetic or having any other significant risk factors were counseled and referred to nearby health centre for further management.

## Results

In this study, initially 368 subjects were selected by the sampling procedure. Out of them 5 subjects refused to participate, 16 subjects were known diabetic, 15 subjects were newly diagnosed as diabetic during the study, 3 women were pregnant, 4 were lactating women, and 5 were suffering from severe physical or mental illness. Thus 48 subjects met exclusion criteria. Finally 320 subjects were included in this study and data were collected from all of these 320 subjects and analyzed.

Mean age of the study participants was  $50.12 \pm 14.43$  years. Socio-demographic characteristics of the study participants are shown in [Table 1]. Present study has found the prevalence of Pre-diabetes as 19.40% among the study subjects. It was 6.4% among subjects aged less than 40 yrs and 23.6% among subjects aged 40 yrs or more. Pre-diabetes was prevalent among 15.9% of the male, 21.1% of the urban inhabitants, 25% of the tribal and 27% of the Christians. About 46% of the participants from upper Socio-economic status (SES), 70.8% with family history of diabetes, 33.6% sedentary, 26.7% hypertensive and 31.7% subjects with high BMI (>25) were pre-diabetic. It was also found among 19.4% of the non-vegetarians, 18.6% of the tobacco users and 20.3% of the alcohol users. The results of bivariate analysis for determining the association between risk

factors and prediabetes is shown in [Table 2]. Among all the factors, age, SES, family history of Diabetes, Hypertension, BMI and physical activity level of the study subjects were identified to be significantly associated with prediabetes. Results of the multivariate analysis using the significantly associated risk factors are shown in [Table 3]. Logistic regression analysis showed that, subjects aged 40 yr and above had higher chance of developing Pre-diabetes than those aged below 40 yr (OR = 20.62, 95% CI: 4.97 – 85.49,  $p < 0.05$ ). Similarly, subjects from upper SES had 4.99 times (95% CI: 1.95 – 12.72,  $p < 0.05$ ) and subjects with family history of Diabetes had 9.72 times (95% CI: 2.51 – 37.61,  $p < 0.05$ ) higher chance of developing Pre-diabetes than their counterpart. Similarly, physical inactivity (OR: 3.52, 95% CI: 1.66 – 7.46) and BMI  $\geq 25$  (OR: 2.79, 95% CI: 1.32 – 5.89) were also identified as significant predictors of Pre-diabetes ( $p < 0.05$ ). Hypertension did not attain the level of statistical significance in the present model.

## Discussion

The present study was undertaken with an aim to estimate the prevalence of Pre-diabetes among adults residing in West Tripura districts and also to study the association between Pre-diabetes and various risk factors.

The present study revealed that 19% of the study subjects are Pre-diabetic, though it was not known to the study participants earlier. The ICMR-INDIAB study, reported the prevalence of pre-diabetes in Tripura as 14.7% which was lower than the findings of present study. (15) This difference may be due to the fact that the present study was limited only to the West Tripura district, which is mostly urban, whereas, the former was conducted throughout the whole state of Tripura. Zhou Xi et al in their study in Qingdao, China, have detected the prevalence of pre-diabetes using fasting capillary blood glucose test as 29.5%, which was higher than the present study. This may be due to the racial difference. (18) Among various factors, Age  $\geq 40$  years, higher socioeconomic status, family history of diabetes, BMI  $\geq 25$  and physical inactivity were found to be the independent predictors of Pre-diabetes. Bivariate analysis has detected significant association between hypertension and Pre-diabetes. But multivariate analysis failed to identify hypertension as a significant predictor of Pre-diabetes. Consumption of tobacco, alcohol, non vegetarian

food and less green leafy vegetable (GLV) also did not show any effect upon determining Pre-diabetes. Similarly, Ramchandran et al, in The National Urban Diabetes Survey, reported that age, BMI and family history of diabetes were significantly associated with IGT.(19) Kacker et al also reported a significant association between pre-diabetes and increasing age, overweight and sedentary life style, however, they also reported a significant association of pre-diabetes with tobacco consumption, dietary habits which was not shown by present study.(20) Mutthnarayanan et al reported that aged and overweight individuals were at higher risk of being pre-diabetic and diabetic which supports the observation of present study, though they also reported male gender, higher waist hip ratio, alcohol intake and hypertension as risk factors for pre-diabetes and diabetes which was different from observation of present study.(21) Dassapa et al in his study reported that old age, overweight, sedentary life style, tobacco consumption and diet habits were significantly associated with prevalence of diabetes and prediabetes.(22) A study from Kerala reported that hypertension and tobacco chewing was significantly associated with diabetes or pre-diabetes whereas physical inactivity shown no association which was different from the observation of present one.(23)

### Conclusion

Prevalence of pre-diabetes in West district of Tripura is found to be higher than the national figure. Age, higher SES, family history of diabetes, physical inactivity and overweight are found to be the independent predictors of Pre-diabetes in this population.

### Recommendation

As a means of high risk strategy, more efforts have to be directed towards Pre-diabetic subjects for controlling the modifiable risk factors in order to slow down the progression of Pre-diabetes to Diabetes and development of further complications in this population.

### Limitation of the study

Present study has limitations that IGT was not performed; instead single measurement of IFG was used for labeling Pre-diabetes due to resource constraints. In this study capillary blood glucose level was estimated considering the fact that fasting

values for venous and capillary plasma glucose are identical.

### Relevance of the study

This study has revealed the hidden burden of Pre-diabetes among the population of West Tripura district, which might have remained unexplored. It will help the policy makers to design control measures.

### Authors Contribution

The first author has designed the study and collected data. The second author has performed data entry and analysis. Both the author contributed in drafting the manuscript.

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**Tables**

**TABLE 1 SOCIO-DEMOGRAPHIC PROFILE OF THE STUDY PARTICIPANTS**

Variables	Frequency (N)	Percentage (%)	
<b>Gender</b>	Male	138	43.1
	Female	182	56.9
<b>Residence</b>	Urban	128	40
	Rural	192	60
<b>Religion</b>	Hindu	275	86
	Muslim	34	10.6
	Christian	11	3.4
<b>Caste</b>	General	130	40.6
	ST	48	15
	SC	85	26.6
	OBC	57	17.8
<b>Education</b>	Illiterate	40	12.5
	Primary	127	39.7
	Secondary	113	35.3
	Graduate	40	12.5
<b>Occupation</b>	Unskilled	21	6.6
	Skilled	37	11.6
	Business	42	13.1
	Service	43	13.4
	housewife	134	41.9
	Professional	15	4.7
	Retired	26	8.1
	students	2	0.6
<b>SES (BG Prasad scale updated on 2017)</b>	Upper	50	15.6
	Upper middle	71	22.2
	Middle	72	22.5
	Lower middle	118	36.9
	lower	9	2.8

Table.1 shows that majority i.e. 56.9% of the study subjects were female, 86% were Hindu by religion, 40.6% belonged to general caste, 39.7% studied up to primary level and 36.9% of them belonged to lower middle class family.

**TABLE 2 ASSOCIATION BETWEEN VARIOUS RISK FACTORS AND PRE DIABETES**

Variables	Pre-diabetic	Euglycaemic	P-value
<b>Age</b>	≥ 40 years	57 (23.6)	0.001
	Below 40 years	5 (6.4)	
<b>Sex</b>	Male	22 (15.9)	0.176
	Female	40 (22)	
<b>Religion</b>	Hindu	53 (19.3)	0.776
	Muslim	6 (17.6)	
	Christian	2 (27.3)	
<b>Residence</b>	Rural	35 (18.2)	0.525
	Urban	27 (21.1)	
<b>Ethnicity</b>	Tribal	12 (25)	0.285
	Non-tribal	50 (18.4)	
<b>Education</b>	Illiterate	9 (22.5)	0.077
	Primary	16 (12.6)	
	Secondary	29 (25.7)	
	Graduate	8 (20)	
<b>SES</b>	Upper	23 (46)	0
	Upper middle	18 (25.4)	
	Middle	14 (19.4)	

	Lower middle	7 (5.9)	111 (94.1)	
	Lower	0	9 (100)	
Family history	Absent	45 (15.2)	251 (84.8)	0
	Present	17 (70.8)	7 (29.2)	
Physical activity	Heavy	0	9 (100)	0
	Moderate	18 (10)	162 (90)	
	Sedentary	44 (33.6)	87 (66.4)	
BMI	<18.49	0	8 (100)	0
	18.5-24.99	29 (13.9)	179 (86.1)	
	≥25	33 (31.7)	71 (68.3)	
Hypertension	Present	24 (26.7)	66 (73.3)	0.039
	Absent	38 (16.5)	192 (83.5)	
Diet	Veg	6 (18.8)	26 (81.3)	0.925
	Non-veg	56 (19.4)	232 (80.6)	
Intake of GLV	More than 3 days a week	44 (18.6)	193 (81.4)	0.536
	3 or less days in a week	18 (21.7)	65 (78.3)	
Use of tobacco	user	46 (18.6)	201 (81.4)	0.532
	Non user	16 (21.9)	57 (78.1)	
Alcohol consumption	Never consume alcohol	47 (19.1)	187 (80.9)	0.824
	Ever consume alcohol	15 (20.3)	59 (79.7)	

Table 2 shows that age ≥40 years, Socio economic status, family history of diabetes, sedentary lifestyle, overweight and hypertension had significant association with Pre-diabetes (p<0.05).

**TABLE 3 RESULT OF BINARY LOGISTIC REGRESSION ANALYSIS**

Variables		Adjusted OR (95% CI)	P value
Age	<40 years	1	0
	≥40 years	20.61 (4.97 – 85.48)	
Socioeconomic status*	Lower	1	0.001
	Upper	4.99 (1.95 – 12.72)	
Family history of DM	No	1	0.001
	Yes	9.72 (2.51 – 37.61)	
Hypertension	No	1	0.527
	Yes	1.26 (0.61 - 2.60)	
Physical activity*	Moderate/Heavy	1	0.001
	Sedentary	3.52 (1.66 – 7.46)	
BMI	<25 kg/m <sup>2</sup>	1	0.007
	≥25 kg/m <sup>2</sup>	2.79 (1.32 – 5.89)	

[\*Socioeconomic status: 1 ≈ Upper class = (Upper class + Upper middle class + Middle class), 0 ≈ Lower class = (Lower class + Lower middle class);

\*Physical activity: 1 ≈ Sedentary, 0 ≈ (Heavy + Moderate workers)] ; Table 3 shows that Age ≥ 40 years, higher socioeconomic status, family history of diabetes, higher BMI (≥25) and physical inactivity were the significant predictors of Pre-diabetes (P<0.05).

**Figure**

**FIGURE 1: SAMPLING ALGORITHM**

