

## Original Research Article

# Prevalence of pre-diabetes in adolescents aged 11-17 years with high risk factors

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**Received:** 14 October 2021

**Accepted:** 30 October 2021

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### ABSTRACT

**Background:** Obesity is a rising global epidemic in children which leads to pre-diabetes and overt diabetes. Identification at early stage helps in early intervention. This study was undertaken to study the prevalence of pre-diabetes in urban school going adolescents aged 11-17 years with high risk factors.

**Methods:** This was a prospective cross-sectional study conducted in Chennai, India between December 2011 and November 2012. Overweight or obese adolescents in the age group 11-17 years, either with family history of diabetes or acanthosis nigricans or both were included. After obtaining informed consent from parents, history was obtained in pre-tested questionnaire.

**Results:** 148 adolescents were enrolled in the study (n=148), 71.62% were females, mean weight was 59.54±10.44 kg, mean height was 150.92±8.62 cm, mean BMI was 26.19±3.23 and mean blood glucose was 82.1 mg/dl. 60.81% of subjects were overweight and others obese. Girls had statistically significant higher mean weight and mean BMI than boys. 78.37% had acanthosis nigricans, 47.29% had family history of diabetes, 12.16% had pre-diabetes and the mean blood glucose in pre-diabetics was 104.9 mg/dl. Pre-diabetes was higher in adolescents with family history of diabetes (p=0.038).

**Conclusions:** Recognition of risk of type 2 diabetes in the asymptomatic pre-diabetes phase needs to be emphasized and targeted screening of high risk children for pre-diabetes seems to be justified. The morbidity and mortality of youth onset type 2 diabetes can be reduced only by early detection and treatment.

**Keywords:** Acanthosis nigricans, Adolescent, Obesity, Overweight, Pre-diabetes

### INTRODUCTION

The epidemic of type 2 diabetes mellitus in children and adolescents parallels the appearance of the obesity epidemic which is also reported in India.<sup>1</sup> Pre-diabetes is a precursor of diabetes and is a state of impaired glucose tolerance or impaired fasting glucose either singly or in combination.<sup>2</sup> This group is an important target for vigorous intervention for primary prevention of diabetes as current data estimates that up to 70% of pre-diabetic subjects eventually get diabetes.<sup>3</sup> South Asians including Indians are at higher risk for insulin resistance due to the presence of higher truncal fat in Indians than Caucasians.<sup>4</sup>

The causative factors for this epidemic include environmental factors like increase in consumption of energy dense processed foods, increase in sedentary lifestyle, decreased physical activity, increase in stress to perform academically and decline in exclusive breastfeeding and foetal factors like thrifty genes, thrifty phenotype and insulin resistance.<sup>5,6</sup> As children can be asymptomatic for prolonged periods, type 2 diabetes in children may remain undiagnosed unless screened. Early diagnosis and preventive measures reduces risks of micro and macrovascular complications.

Identification of prediabetes provides opportunity to establish healthy eating and physical activity behaviour to

protect them against future obesity and its complications. As such studies were lacking in India and no study from southern region, the present study was undertaken to study the prevalence of pre-diabetes in urban school going adolescents aged 11-17 years with high risk factors.

**METHODS**

This was a prospective cross-sectional study conducted in school children in the age group of 11-17 years (children from Chennai corporation middle, high and higher secondary schools affiliated to institute of child health and hospital for children (ICH and HC) school health cell, Chennai, Tamil Nadu, India) between December 2011 and November 2012. Adolescents who were overweight or obese according to WHO Z-scores, either with family history of diabetes or presence of acanthosis nigricans or both were included in the study.<sup>7</sup> Children with proven diabetes and those with chronic drug intake or chronic medical illness were excluded. Overweight was defined as a body mass index (BMI) of  $> \pm 1$  SD to  $< \pm 2$ SD of WHO Z score and obesity was defined as a BMI of  $> \pm 2$ SD. Pre-diabetes was defined as fasting plasma glucose value between 100 mg/dl to 125 mg/dl.<sup>2</sup> Simple random sampling technique was employed and sample size was calculated as 148. Multiple sessions

were conducted with school teachers and parents to explain about study details. Pre-designed and pre tested questionnaire was employed for eliciting detailed medical history and family history of diabetes, with parental help when necessary. Written informed consent was obtained from parents or legal guardian along with oral consent from adolescents. Venous blood samples were drawn after a minimum of eight hours fasting, for plasma glucose estimation by glucose oxidase-peroxidase method. Data entry and analysis were done using SPSS software version 17.0 (IBM, Atlanta, USA). Descriptive data were given in summary statistics. Comparison of continuous variables was analyzed with independent sample test.  $P < 0.05$  was considered significant.

**RESULTS**

In the present study on prevalence of pre-diabetes in urban school going adolescents, the total number of children enrolled was 148 (n=148). Most of the subjects were females (71.62%) (n=106/148). Age distribution of the test subjects was as given in Figure 1. Weight of the children enrolled varied between 32 kg and 89 kg with a mean of  $59.54 \pm 10.44$  kg. Height of the enrolled children varied between 121 cm and 178 cm with a mean of  $150.92 \pm 8.62$  cm. BMI varied between 20 and 36.50 with a mean of  $26.19 \pm 3.23$ . Year wise anthropometric data of the test subjects were as given in Table 1.

**Table 1: Anthropometric data distribution of adolescents enrolled in the study (n=148).**

Age (in years)	Number of subjects	Weight (in kg)	Height (in cm)	BMI
		Mean and SD	Mean and SD	Mean and SD
11	8	42.88±6.24	136.63±11.49	22.85±2.98
12	19	53.05±9.06	147.95±4.89	24.55±3.58
13	26	56.31±6.93	149.35±6.31	25.33±1.85
14	24	59.17±10.24	150.67±7.48	25.89±3.12
15	26	63.12±9.42	155.62±8.29	26.13±2.23
16	31	65.10±6.81	152.90±6.11	28.16±3.23
17	14	65.57±12.28	153.36±11.73	28.15±3.50

**Table 2: Differences in anthropometric data between genders.**

Anthropometric data	Gender	Number of subjects	Mean with SD	P value
Height (in cm)	Male	42	151.14±7.70	0.843
	Female	106	150.83±8.99	
Weight (in kg)	Male	42	56.38±9.17	0.014
	Female	106	60.79±10.69	
BMI (in kg/m <sup>2</sup> )	Male	42	24.57±2.19	<0.001
	Female	106	26.83±3.36	

**Table 3: Prevalence of pre-diabetes among adolescents with acanthosis nigricans.**

Prevalence of pre-diabetes		Pre-diabetes			
		Absent		Present	
		No.	%	No.	%
Acanthosis nigricans	Absent	29	90.62	3	9.37
	Present	101	87.06	15	12.93
<b>Total</b>		130	87.83	18	12.16

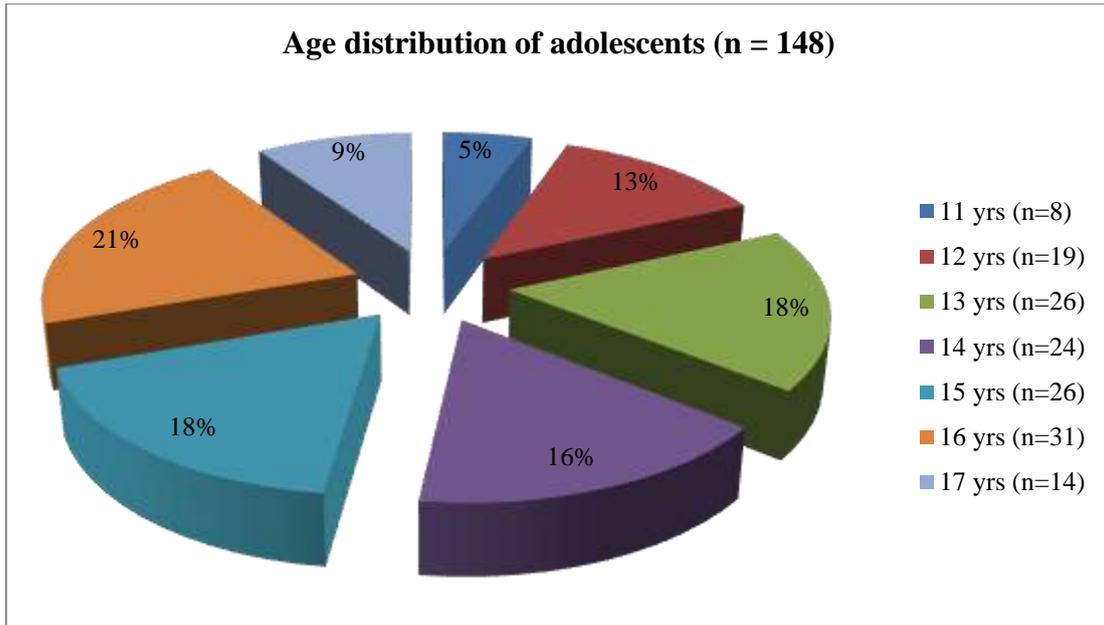


Figure 1: Age distribution of adolescents enrolled in the study.

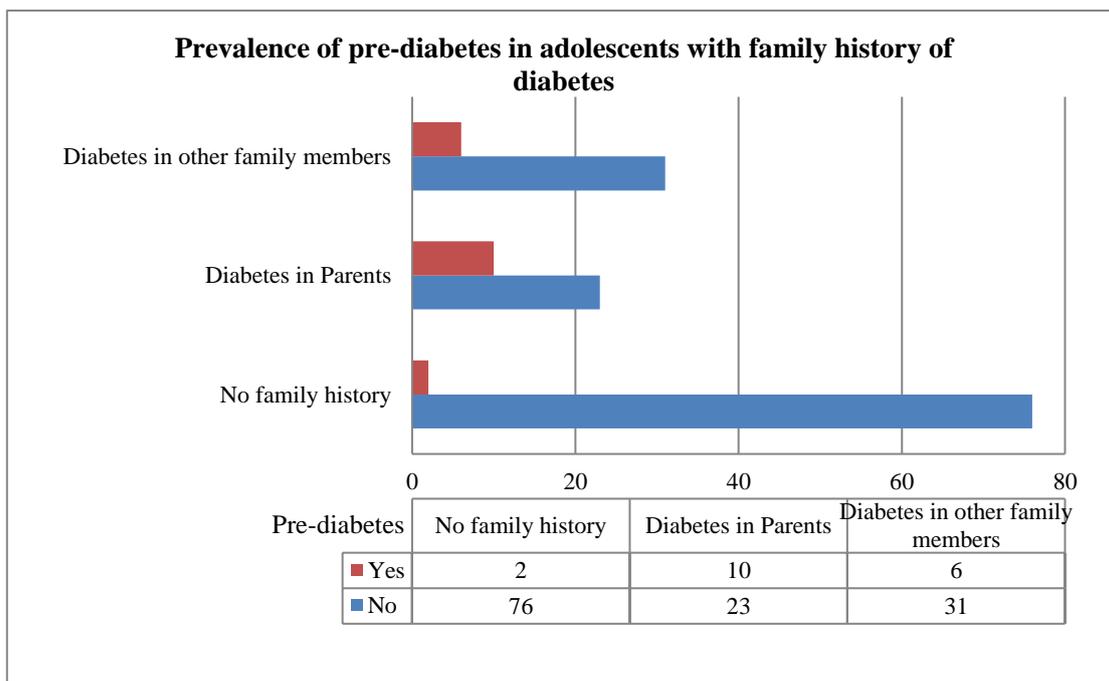


Figure 2: Prevalence of pre-diabetes in adolescents with family history of diabetes.

Based on WHO Z-scores, 60.81% of the test subjects were overweight (n=90/148) while others were obese (39.19%) (n=58/148). Gender wise differences in anthropometric data were as given in Table 2. Girls had more mean weight and higher BMI than boys and the difference was statistically significant

Most of the study subjects had acanthosis nigricans (78.37%) (n=116/148). Family history of diabetes was

found in 47.29% of the study subjects (n=70/148). While the prevalence of pre-diabetes (fasting blood glucose of 100-125 mg/dl) was 12.16% (n=18/148) among the study subjects, it was higher in females (13.21%) (n=14/106) than males (9.52%) (n=4/42). The mean blood glucose of study subjects with pre-diabetes was 104.9 mg/dl while the mean blood glucose of normal subjects was 82.1 mg/dl.

The prevalence of pre-diabetes was higher at the age of 13 years in the present study (19.23%) (n=5/26). Prevalence of pre-diabetes was higher in adolescents with family history of diabetes in parents (30.30%) (n=10/33) when compared to those without family member with diabetes (2.63%) (n=2/76) (Figure 2). This difference was statistically significant (p=0.038). Pre-diabetes was higher in obese adolescent subjects (18.96%) (n=11/58) than overweight subjects (7.77%) (n=7/90). Prevalence of pre-diabetes in adolescents with acanthosis nigricans was 12.93% (n=18/148). While acanthosis nigricans was present in 83.33% of adolescents with pre-diabetes (n=15/18), it was also present in 77.69% of adolescents without features of pre-diabetes (n=101/130) (Table 3).

## DISCUSSION

According to International diabetes federation (IDF), India had around 87.61 million patients with diabetes and this may further rise to 115.6 million by the year 2030.<sup>8</sup> In the present study to study pre-diabetes in adolescents, school children were chosen because children can be easily educated about the need to practice a healthy diet and exercise routine at school, to make healthier choices which can prevent progression of pre-diabetes to diabetes.

In the present study, 148 overweight/obese adolescents were included to study the prevalence of pre-diabetes. Body weight and BMI were found to be higher in females across all age groups. This was similar to results from the studies by Subramanian et al and Shabana et al but different from the study by Zdravković et al who showed higher prevalence in males.<sup>9-11</sup> Females had a greater preponderance for being overweight owing to their inherent hormonal differences.

In the present study, 12.16% (n=18/148) had pre-diabetes. This was similar to the study by Vukovic et al (16.2%).<sup>12</sup> Overweight, obesity and positive family history influence the progression of pre-diabetes. Studies in patients with impaired fasting glucose had shown that lifestyle modification and treatment with pharmacological agents like metformin can prevent the onset of diabetes.<sup>13</sup>

Prevalence of pre-diabetes in adolescents with risk factors was 13.21% (n=14/106) in females and 9.52% (n=4/42) in males. This was higher than the results obtained in the study by Ranjani et al who showed that 4.2% of girls and 3.2% of boys had pre-diabetes; in children aged 12-19 years.<sup>14</sup> Overall prevalence in the present study was 12.2% which indicated that the children had more risk than general population. But the study by Michael et al showed impaired glucose intolerance in 28% of obese Hispanic children.<sup>15</sup>

Family history of diabetes was present in 88.88% (n=16/18) of adolescents with pre-diabetes. This was similar to the established evidence that nearly 80% of

children with diabetes have a positive family history of diabetes.<sup>16</sup> In the present study, 19% of obese children had pre-diabetes. This was similar to the study results by Kaur et al who communicated a 18.2% prevalence of impaired glucose tolerance in obese children.<sup>17</sup> Identifying high risk individuals by simple screening methods and institution of lifestyle modification can help prevent development of diabetes in adolescents. Increase in physical activity and daily sports for all children should be recommended. Life style modifications should be encouraged and implemented at school level itself.

## CONCLUSION

Recognition of risk of type 2 diabetes in the asymptomatic pre-diabetes phase need to be emphasized and targeted screening of high risk children for pre-diabetes seems to be justified. The morbidity and mortality of youth onset type 2 diabetes can be reduced only by early detection and treatment.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Balamurugan K, Ponprabha R, Sivashankari V. Prevalence of pre-diabetes in adolescents aged 11-17 years with high risk factors. *Int J Res Med Sci* 2021;9:3648-3652.