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Anthropometric indicators as predictor of pre-diabetes in Indian adolescents

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ABSTRACT

Introduction: In India, there are approximately 41 million diabetics to date. Impaired glucose tolerance or pre-diabetes may occur as early as adolescence.
Objective: To find out the cut-off values of body mass index (BMI) and waist circumference to predict pre-diabetes in adolescents in north India.
Methods: A cross-sectional study was conducted among 526 students aged 17–19 years, in the Institute of Paramedical Sciences, Chatrapati Shahuji Maharaj University, Kanpur. A pre-tested questionnaire was used and the diagnostic criteria of the American Diabetic Association were applied. Receiver operating characteristic(ROC) analysis was used to assess the cut-offs of BMI and waist circumference for predicting prediabetes.
Results: ROC analysis showed that BMI is a good predictor of prediabetes for both boys and girls.Area under the ROC curve was 0.828 for boys and 0.838 for girls, respectively. The cut-off values of BMI for predicting prediabetes were identified as $\geq$22.8 kg/m^2 in boys and $\geq$20.5 kg/m^2 in girls. Upon ROC analysis for waist circumference, it was observed that it was a good predictor of prediabetes both for boys (area under the curve 0.804) and girls (area under the curve 0.795). The cut-offs for waist circumference for predicting prediabetes were found to be $\geq$82.5 cm for boys and $\geq$80.3 cm for girls.
Conclusion: BMI and waist circumference estimation can be done for early detection of prediabetes in adolescents for further diagnostic evaluation and management.

1. Introduction

Diabetes mellitus is a metabolic disorder defined by chronic hyperglycemia with deranged fat, carbohydrate and protein metabolism that results from improper secretion or action of insulin.[1] It is a modern day epidemic. The WHO Global Report on Diabetes has revealed that the number of adult diabetics in the world was 422 million in 2014 in comparison to 108 million in 1980.[2] The age standardized prevalence of diabetes has become 8.5% in the adult population, almost double that of the 4.7% in 1980. More than 80% of deaths due to diabetes occur in middle and low income countries.[3,4] WHO estimates that diabetes will become the seventh most common cause of mortality, worldwide, in the year 2030.[5]

India is the diabetes capital of the world because there are around 41 million Indians suffering from diabetes till date and every fifth person in world, having diabetes, is an Indian.[6,7] Recent studies have revealed that the occurrence of diabetes mellitus is

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Table 1
Characteristics of the study population.

Parameter	Boys(N = 277)		Girls(N = 249)	
	Mean	SD	Mean	SD
Age	18.5	1.5	17.9	1.8
Weight	59.9	10.2	49.4	10.1
Height	164.9	7.9	154.1	5
BMI	22	3.5	20.8	4.1
Waist circumference	80.2	15.3	72.9	7.5
Fasting blood glucose	92.2	12.4	87.9	14.8

increasing among children and adolescents in India.[8–10] Screening for glucose intolerance in all children and adolescents is not recommended in the current scenario, however it is recommended in high-risk populations.[11]

There are two main types of diabetes mellitus (DM):Type 1 DM results from the inability of the pancreas to produce enough insulin. Its cause is unknown.[12] Type 2 DM occurs due to insulin resistance, in which the peripheral cells fail to respond to insulin properly. As the disease progresses, failure to produce insulin may also occur. The most common risk factor of type 2 DM is excessive body weight and sedentary lifestyle. Type 2 DM accounts for more than 90% of the diabetes cases worldwide. It is difficult to diagnose early, as it is mostly asymptomatic and usually presents with complications like nephropathy, cardiovascular disease, retinopathy, neuropathy, cerebrovascular disease and peripheral vascular disease.[12] It can go undetected for 9–12 years and, consequently, present with complications.[13]

Recent studies have revealed that around half of the diabetics in the world are undiagnosed.[12] American Diabetic Association has introduced a new category of blood glucose levels, preceding the onset of diabetes, known as prediabetes. Individuals with prediabetes, have a higher risk of development of diabetes in the future.[14] American Diabetic Association has defined pre-diabetes as – Impaired Fasting Glucose, when fasting plasma glucose level ranges from 100 to 125 mg/dl and Impaired Glucose Tolerance, when plasma glucose level 2-h after an oral glucose tolerance test ranges from 140 to 199 mg/dl.[15,16] Screening for prediabetes can lead to early diagnosis and treatment and prevention of complications.[15]

Keeping in view that the onset of glucose intolerance can occur in the adolescent age group and that early diagnosis can prevent grave complications of diabetes, it is the need of the hour to identify those adolescents who are at risk. Since very few studies have been conducted among Indian adolescents, this study was planned to find out the cut-off values of BMI nd waist circumference for predicting pre-diabetes in adolescents in the Indian population.

2. Material and methods

2.1. Study design and sample size

A cross-sectional study was conducted with a minimum sample size of 506, calculated by taking the prevalence of glucose intolerance among adolescents as 28.2%, as observed in the ICMR-INDIAB study.[17]

Sample size was estimated using the formula, $N = Z_{(1-\alpha/2)}{}^2 pq/d^2$; where α was taken at 5% level of significance; p = prevalence of glucose intolerance = 28.2%; q = 100-p = 71.8%; and d = margin of error = 4%. Therefore, the minimum sample size obtained was 506.

2.2. Sampling

The study setting was the Institute of Paramedical Sciences, affiliated to Chatrapati Shahuji Maharaj University, Kanpur. The Institute offers a course of 4 years in Paramedical Sciences

and admits around 150 students in a year. All the students enrolled in the Institute in all 4 years were enlisted. All students who were present on the day of the interview and willing to be included in the study were selected. Written informed consent was taken from the students as well as from their parents/guardians. Ethical clearance was taken from the Institutional Ethical Committee. The data was analyzed for 526 subjects. Among the study subjects there were 277 boys and 249 girls, aged between 17 and 19 years.

2.3. Methodology

Data was recorded on a pre-designed and pre-tested questionnaire and data was collected regarding the following variables: age, socioeconomic status, family history of diabetes, physical activity, dietary pattern, weight, height, BMI and waist circumference. Fasting blood samples were collected on the day following the day of interview. A 10 ml blood sample was collected from each subject: 4 ml in EDTA tube and 6 ml in plain tube. The samples were taken to the laboratory in the Deptt. of Biochemistry, Chatrapati Shahuji Maharaj University, Kanpur and were centrifuged. Glucose levels were estimated. Enzymatic colorimetric GOD – PAP method was used to estimate fasting plasma glucose.

Subjects were classified as normoglycemic or hyperglycemic using the diagnostic criteria of the American Diabetic Association (ADA). Subjects with fasting plasma glucose level <100 mg/dl (after fasting for 8 h) were classified as normoglycemic, those with fasting plasma glucose level between 100 and 125 mg/dl were classified as prediabetic and those with fasting plasma glucose level ≥126 mg/dl were classified as diabetic.[15]

To measure body weight, the subject was made to stand motionless on Krup's weighing machine(least count 0.5 kg). The scale was calibrated to zero before every reading. To measure height, the subject was made to stand in an erect position against a vertical surface, and the head stationed such that the upper margin of the external auditory meatus was in line with the inferior margin of the bony orbit. A hard board was held vertical to the wall, just over the head, height was marked on the wall and was measured with a measuring tape (least count 0.5 cm). Waist circumference was estimated, at the level of the umbilicus, keeping the subject in an erect position, breathing normally.

Physical activity was estimated as increments in BMR. In the present study, the subject's BMR factor was calculated by questioning him/her about the type of activity and time spent in each activity in the last 24 h.[18] Average daily level of activity was classified as sedentary, moderate or heavy, expressed as a multiple of BMR as follows:

Gender	Sedentary	Moderate	Heavy
Boys	1.55	1.78	2.10
Girls	1.55	1.64	1.82

2.4. Statistical analysis

Microsoft Excel and MedCalc12.7.5were used to compile and analyse the data, respectively. Receiver operating characteristic

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