

Original Research Article

Prevalence of impaired glucose tolerance test and diabetes in overweight, obese and apparently healthy school going adolescents

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ABSTRACT

Background: Adolescence is a period of transition from childhood to adulthood. It occupies a crucial position in the life of human beings characterized by an exceptionally rapid rate of growth in physical, mental, sexual, and psychological behavior etc. The present study was planned to study the prevalence of impaired glucose tolerance amongst overweight, obese and apparently healthy school going adolescents in the city of Jaipur, Rajasthan.

Methods: The study has been conducted in the Department of Pediatrics of Mahatma Gandhi Medical College of Mahatma Gandhi University of Medical Sciences and Technology, Jaipur. The study was a cross sectional analytical study conducted in schools of Jaipur. This study was done from August 2011 to November 2011 and 180 patients of aged between 10 to 18 years of age were enrolled.

Results: In this study, it was found that the prevalence of overweight to be 32.65 percent in males and 34.15 percent in females. It was seen that 33.67 percent males and 32.93 percent females belonged to the obese category. Out of 180 adolescents, 25 (13.89 percent) were found to have IGT and only 1 was found to have type 2 diabetes (0.5 percent). Out of 25 students with IGT, 15 were boys and 10 were girls. Among these 25 students with IGT, 9 were overweight and 16 were obese. 15 percent of overweight student and approximately 26 percent of obese students had IGT. The association of IGT and increased BMI was found to be highly significant.

Conclusions: The present study highlights the fact that type 2 diabetes in children occurs in developing countries and there is an increase need to look for type 2 diabetes in overweight and obese children and adolescents in India. Therefore, it is recommended that all obese and overweight adolescents should be screened at least yearly for type 2 diabetes mellitus using OGTT so that timely intervention can be done.

Keywords: Diabetes, Impaired glucose tolerance test, Obesity, Overweight

INTRODUCTION

Adolescence is a period of transition from childhood to adulthood. It occupies a crucial position in the life of human beings characterized by an exceptionally rapid rate of growth in physical, mental, sexual, and psychological behavior etc.¹

Childhood overweight and obesity are global nutritional concerns that are on the rise. Obesity has serious long term consequences; hypertension, hypercholesterolemia, type 2 diabetes mellitus, left ventricular hypertrophy, non-alcoholic steatohepatitis, asthma, obstructive sleep apnea, mental health concerns and orthopedic disorders have been linked to obesity.²⁻⁴ Parallel to the epidemic of obesity in children, a second epidemic of type 2 diabetes

mellitus (T2DM) is also emerging. Diabetes mellitus is one of the leading chronic diseases of childhood and adolescence. Diabetes mellitus affects the quality of life, has a major impact on their families and has significant public health impact.⁵

The primary driver of the epidemic of diabetes is the rapid epidemiological transitions associated with changes in dietary patterns and decreased physical activity as evident from the higher prevalence of diabetes mellitus in the urban population.⁶

The data on prevalence of diabetes in school going children is scanty. There are limited number of studies providing data on prevalence of impaired glucose tolerance amongst school going children in our country.⁷ A study conducted amongst school children in New Delhi found the prevalence of type 2 diabetes mellitus and impaired glucose to be 1.3 percent and 18.2 percent, respectively amongst obese adolescents.⁸

While another study conducted amongst school children in Mysore found the prevalence of diabetes and pre-diabetes to be 0.6 percent and 3.7 percent respectively.

The present study was planned to study the prevalence of impaired glucose tolerance amongst overweight, obese and apparently healthy school going adolescents in the city of Jaipur, Rajasthan.

METHODS

The study has been conducted in the Department of Pediatric of Mahatma Gandhi Medical College of Mahatma Gandhi University of Medical Sciences and Technology, Jaipur. The study was a cross sectional analytical study conducted in schools of Jaipur. This study was done from August 2011 to November 2011.

The sample size was calculated to 180 by keeping in view an expected prevalence of IGT as 18.2 percent in overweight and obese adolescents.

Subjects were adolescents in the age group of 10 years to 18 years studying in above mentioned schools in the city of Jaipur.

Inclusion criteria

- Boys and girls in the age group of 10-18 years
- BMI < 85th percentile as normal, between 85th percentile and 95th percentile as overweight and >95th percentile as obese
- Consent of parents
- Permission letter of principals of respective schools
- Fasting for ten hours

Exclusion criteria

- Absence of consent of parents and/or principal,

- Absence of fasting for the hours,
- Children with active illness or chronic illness or having feature suggestive of genetic or endocrinal origin of obesity or on medication or any other factor that can alter the results.

Data collection

The institutional ethical review board of Mahatma Gandhi Medical College, Jaipur approved the study protocol.

A written informed consent was obtained from the head of institution, parents before data collection. Appropriate data were collected from the adolescents using a pre-tested and validated questionnaire. The questionnaire included data on socio-demographic profile (age, sex, parents profile, physical activity, and family history), dietary pattern and nutrient intake.

Measurements

Anthropometric measurements of height, weight, mean arm circumference, neck circumference, waist circumference and hip circumference, blood pressure were measured utilizing standard methodology.⁹

Weight was measured by using SECA electronic weighing scale to the nearest 100gms. For measurement of height calibrated weight chart fixed on the wall was used and measurement was done to the nearest 0.1cm. The mean arm circumference, neck circumference, waist circumference and hip circumference were measured with the help of a non-stretchable fiber glass tape by cross tap technique to the nearest 0.1cm.

BMI (body mass index) was calculated using the formula weight in kg divided by height in meter square [wt(kg)/ht(m)²].

BMI = Weight/Height

Agarwal charts of BMI for age and sex were used as reference. Children with BMI above 95th percentile were considered as obese, children between 85th to 95th percentile were considered as overweight and below 85th percentile were considered as normal.

Oral Glucose Tolerance Test

Students who fulfilled the criteria were requested to come to the hospital at

9 AM in the Biochemistry laboratory of Mahatma Gandhi Medical College and Hospital after overnight fast of at least 10 hours.

Oral glucose tolerance test was carried out as per standardized procedure as follows.¹⁰

- A venous sample was withdrawn for fasting blood glucose estimation.
- Afterwards, the students were administered glucose load of 1.75gm/kg. of body weight dissolved in water (maximum of 75gm) to be finished slowly over 5 minutes.
- Another venous blood sample was taken at 2 hours post glucose load.

The samples were collected in SAPSUN fluoride oxalate vial, a minimum of 1ml of blood. The samples were processed within 30 minutes. The samples were estimated for blood glucose values by peroxidase method by Merck semi auto-analyzer. The blood glucose concentration was categorized according to the WHO/IDF/ADA guidelines mentioned below.

Statistical Analysis

All statistical analyses were performed using SPSS software (SPSS version 13; SPSS Inc, Chicago, IL). Chi square test was applied. $P < 0.05$ was considered statistically significant.

RESULTS

A total of 180 students participated in the study. The study group included 98 boys and 82 girls. The students were grouped under early (10-13 years), middle 14-16 years and late adolescence (17-18 years). The number of students in each group was 20, 58 and 102 respectively.

Table 1: Distribution of adolescents according their age and sex.

Stage of Adolescence (Age in years)	Male (%)		Female (%)		Total (%)	
	No.	%	No.	%	No.	%
Early (10-13)	11	11.22	9	10.98	20	11.11
Middle (14-16)	23	23.47	35	42.68	58	32.22
Late (17-18)	64	65.31	38	46.34	102	56.67
Total	98	100.00	82	100.00	180	100.00

Chi-square = 10.412, df=4, p=0.061

Table 2: Relationship of sex and obesity among adolescents.

Obesity (on the basis of BMI)	Male (%)		Female (%)		Total (%)	
	No.	%	No.	%	No.	%
Normal	33	33.67	27	32.93	60	33.33
Overweight	32	32.65	28	34.15	60	33.33
Obese	33	33.67	27	32.93	60	33.33
Total	98	100.00	82	100.00	180	100.00

Chi-square = 0.045, df=2, p=0.978

Table 3: Relationship of period of adolescence and BMI

Obesity (on the basis of BMI)	Stage of Adolescence (Age in years)							
	Early (10-13)		Middle (14-16)		Late (17-18)		Total	
	No.	%	No.	%	No.	%	No.	%
Normal	7	35.00	16	27.59	37	36.27	60	33.33
Overweight	9	45.00	14	24.14	37	36.27	60	33.33
Obese	4	20.00	28	48.28	28	27.45	60	33.33
Total	20	100.00	58	100.00	102	100.00	180	100.00

Chi-square = 9.419, df=4, p=0.051

Table 4: Relationship of sex and result of IGT test among Adolescents

Result of IGT	Male (%)		Female		Total	
	No.	%	No.	%	No.	%
Positive	15	15.31	10	12.20	25	13.89
Negative	83	84.69	72	87.80	155	86.11
Total	98	100.00	82	100.00	180	100.00

Chi-square = 0.148, df=1, p=0.700

Table 5: Relationship of IGT and BMI among adolescents.

Obesity (on the basis of BMI)	Positive		Negative		Total	
	No.	%	No.	%	No.	%
Normal	0	0.00	60	100.00	60	100.00
Overweight	9	15.00	51	85.00	60	100.00
Obese	16	26.67	44	73.33	60	100.00
Total	25	13.89	155	86.11	180	100.00

Obesity and overweight

In this study, we found the prevalence of overweight to be 32.65 percent in males and 34.15 percent in females. It was seen that 33.67 percent males and 32.93 percent females belonged to the obese category. No statistically significant difference was observed between sexes ($p=0.978$).

We observed that the prevalence of overweight was 45 percent in early adolescence and 36.27 percent in late adolescence. However, the prevalence of obesity was 20 percent in early adolescence which increased to 27.45 percent in late adolescence.

Impaired Glucose Tolerance (IGT) and Diabetes Mellitus

Out of 180 adolescents, 25 (13.89 percent) were found to have IGT and only 1 was found to have type 2 diabetes (0.5 percent). Out of 25 students with IGT, 15 were boys and 10 were girls. The observation was not significant.

Relationship of IGT and BMI

Among these 25 students with IGT, 9 were overweight and 16 were obese. 15 percent of overweight student and approximately 26 percent of obese students had IGT. The association of IGT and increased BMI was found to be highly significant ($p=0.00$).

DISCUSSION

The present study included more boys than girls (Table 1). The difference was not significant ($p=0.061$). There are other studies done in the past which have included unequal number of boys and girls. Study conducted by Kapil and colleagues in New Delhi studied 64.5 percent boys.¹¹ While another study conducted by Chatwal and colleagues in Ludhiana included larger number of girls as compared to boys (52.1 percent vs. 47.9 percent, $p=0.00$).¹²

The prevalence of overweight was 32.65 percent in boys and 34.15 percent in girls and the prevalence obesity in our study was 33.67 percent in boys and 32.73 percent in the girls. A study conducted in New Delhi in 2001 reported the prevalence of overweight to be 23.1 percent

among boys and 24.7 percent among girls; while the prevalence of obesity boys 8.3 percent among boys and 7.4 percent among girls.¹¹ However in a study conducted in Ludhiana, Punjab estimated the overall prevalence of obesity to be 11.1 percent and overweight to be 14.2 percent.¹² The difference in the observation in our study is possibly due to smaller sample size.

Association of overweight and obesity with risk factors

Age and sex

The prevalence of overweight among adolescents was found to be highest in the age group of 10 - 13 years at 45%, decreasing to 24.14 percent in the age group of 14-16 years and then again increasing to 36.27 percent during 17-18 years of age (Table 3). However, the prevalence of obesity was highest in the middle adolescence at 48.28 percent. The study done in Delhi found that the maximum prevalence of obesity was in the age group of 10-12 years (38.7 percent).¹¹ Study conducted by Chatwal and colleagues has reported that prevalence of both overweight and obesity decreased significantly with increasing age till 14 years (from 21 percent to 10.6 percent for overweight and 18.5 percent to 7.6 percent for obesity) but tended to rise at 15 years (12.8 percent to 9.2 percent, respectively).¹²

Both the above-mentioned studies did not include adolescents in the age group of 17-18 years which have been included in present study.

The proportion of overweight and obese adolescents in the age group of 17-18 years was 54.16 percent, as observed in current study. Amongst girls, it was observed that 55.56 percent ($n=5$) of girls in their early adolescence were overweight which decreased to 34.29 percent ($n=12$) during middle adolescence and further decreased to 28.95 percent ($n=11$) during late adolescence. It was also observed that the percentage of girls who were overweight increased from 33.33 percent ($n=3$) during early adolescence to 45.71 percent ($n=16$) during middle adolescence and later decreased to 21.05 percent ($n=8$) during late adolescence. The association of BMI with age amongst girls was significant ($p=0.023$). This decrease in prevalence of overweight and obesity amongst girls during late adolescence could be due to increased consciousness regarding body image and appearance. Similar trend was observed in the study conducted in

Hyderabad where the prevalence of the overweight among girls decreased from 10.8 percent at the age of 15 years to 9.2 percent at 17 years.¹³ This can be explained by the fact that there is an increase in adipose tissue and overall in children during puberty. Number of fat cells increased during periods of rapid growth till 16 years of age.¹³ Also, in the study done by Kapil and colleagues in New Delhi in 2001, the prevalence of overweight and obesity was observed to decrease from 28.02 percent and 6.5 percent, respectively during early adolescence to 27.2 percent and 4 percent, respectively during middle adolescence. This study, however, did not include student above 16 years of age.

The difference of overweight and obesity observed between sex was not significant ($p=0.978$) (Table 2). The prevalence of overweight was 32.65 percent in boys and 34.15 percent in girls and the prevalence obesity in our study was 33.67 percent in boys and 32.73 percent in the girls. Similar insignificant difference between sex was observed in the study conducted in Hyderabad.¹³ This study found overweight. The difference was insignificant ($p>0.05$). Study done by Chatwal and colleagues found that more boys were overweight (15.7 percent vs. 12.9 percent) as well as obese (12.4 percent vs. 9.9 percent) as compared to girls.¹² Kapil and colleagues also observed similar findings in their study in New Delhi.¹¹ The study found an overall prevalence of overweight to be 23.1 percent among boys and 24.7 percent among girls, while the prevalence of obesity was higher in boys (8.3 percent vs. 7.4 percent) as compared to girls.

Impaired Glucose Tolerance (IGT) and Type 2 Diabetes mellitus (T2DM)

In our study, the prevalence of IGT is 13.89 percent among adolescents. The prevalence of impaired glucose tolerance was 15 percent and 26 percent in overweight and obese children, respectively (Table 4). Only one obese subject was found to have type 2 diabetes mellitus (0.5 percent).

The results are in concordance with similar studies done so far in India. In a study from New Delhi carried out in the year 2010, it has been reported that the prevalence of IGT and type 2 diabetes was as 18.2 percent and 1.3 percent respectively.⁸ The study included 154 obese adolescents in the age group of 6 to 18 years. In another study done in Mysore city amongst school children in the group 5 to 10 years, the prevalence of prediabetes and type 2 diabetes was reported as 3.7 percent and 0.6 percent.⁷ The figures in this study are lower than those observed in present study. This study included children in the age group of 5-10 years, while our study included adolescents in the age group of 10 to 18 years. In a study OGTT, no case of type 2 diabetes was detected.¹⁴ This study included 2990 children who has normal blood glucose during screening (OGTT). Thus, it seems that there is an increasing trend of prevalence of IGT and T2DM amongst adolescents in India.

Studies done in the European countries have estimated the prevalence of IGT between 7.45 percent to 36.3 percent.¹⁵⁻¹⁸ In Taiwan, the rate of diagnosis of T2DM in the screening program was 0.9 percent and 1.53 percent in boys and girls, respectively in community level.¹⁹ Prevalence of prediabetes was 19.2 percent in 280 overweight Japanese children.²⁰ Study conducted in Australia over a period of 5 years (1989 to 1994) has shown increase in the prevalence of T2DM from 1.3 percent to 8.1 percent.²¹

Association of IGT with known risk factors

Sex

It was seen that 15.31 percent of males and 12.20 percent of females had IGT (Table 4). The association was statistically significant ($p=0.700$).

Similar non-significant association of IGT with sex was observed in a cross sectional study conducted in Mysore to study the prevalence of prediabetes in school going children.⁷ This study found the prevalence of pre diabetes 3.9 percent in boys and 3.4 percent in girls.⁷ The other study done by Kaur and colleagues in New Delhi in 2010 have not mentioned the difference in the prevalence of IGT with sex.⁸

BMI

Among these 25 students with IGT, 9 were overweight and 16 were obese (Table 5). The association of IGT and increased BMI was found to be highly significant ($p=0.00$).

A positive association between overweight and obesity and risk of type 2 diabetes has been established repeatedly in many cross sectional and prospective studies.^{15-18,22} Study conducted in New Delhi has found the prevalence of IGT to be 18.2 percent amongst obese children.⁸ Increasing prevalence of type 2 diabetes among children in India and other countries has been attributed to epidemic of obesity and overweight among children. Sinha and colleagues have reported the prevalence of impaired glucose tolerance to be 21 percent amongst obese adolescents in the U.S.²² Similarly, study done in Germany has reported a prevalence of IGT as 36.3 percent and T2DM as 5.9 percent amongst obese adolescent.¹⁵

Type 2 Diabetes Mellitus

In present study, we found the overall prevalence of T2DM to be 0.5 percent as stated above. The prevalence of T2DM was 0.8 percent amongst overweight and obese adolescents. Only 1 student was found to be suffering from T2DM. This student was a 13 years old boy who belonged to the obese category. He was a student consumption of fast food and physical activity for less than 30 minutes less than 3 days per week. This was an

isolated case; hence no further comment can be made at present.

CONCLUSION

From the observations of our study, it was concluded that:

- The prevalence of overweight was 32 percent in boys and 34 percent in girls and the prevalence obesity was 33 percent in boys and 32 percent in the girls.
- There was no significant difference in overweight and obesity between boys and girls.
- The overall prevalence of IGT is 13.8 percent among adolescents. The prevalence of IGT was 15.31 percent amongst adolescent boys and 12.20 percent amongst adolescent girls.
- The difference in IGT between boys and girls was not significant.
- The prevalence of impaired glucose tolerance was 15 percent and 26 percent in overweight and obese children, respectively. Only one obese subject was found to have type 2 diabetes mellitus (0.5 percent).
- It was observed in present study, that BMI had significant association with IGT ($p=0.00$) which signifies the increasing prevalence of type 2 diabetes among children in India and other countries and which has been attributed to epidemic of obesity and overweight among children.

The present study highlights the fact that type 2 diabetes in children occurs in developing countries and there is an increase need to look for type 2 diabetes in overweight and obese children and adolescents in India. Therefore, it is recommended that all obese and overweight adolescents should be screened at least yearly for type 2 diabetes mellitus using OGTT so that timely intervention can be done. Strategies for obesity prevention, weight reduction, promotion of healthy lifestyles and regular monitoring are necessary to prevent the onset and early detection of type 2 diabetes during childhood and adolescence.

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