Research Article

STUDY OF ORAL GLUCOSE TOLERANCE TEST IN OVERWEIGHT AND OBESE URBAN SCHOOL CHILDREN BETWEEN 5 TO 15 YEARS OF AGE.

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ABSTRACT

Several studies have reported increases in the occurrence of type 2 diabetes in children and adolescents. People with pre-diabetic states such as impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) are at increased risk for developing diabetes. The objective of this study was to determine the prevalence of impaired glucose tolerance in overweight and obese urban school children. The subjects were taken from two schools of Mysore city. The subjects who are overweight and obese underwent oral glucose tolerance test (OGTT; 1.75 mg of glucose per kilogram of body weight, up to a maximum of 75gm of glucose) after a 12-hour overnight fast. Participants were classified as overweight and obese when BMI was >85th and <95th percentile and >95th percentile. Fasting glucose level was also measured (n=100). Impaired glucose tolerance (IGT) was defined, as a fasting plasma glucose level of less than 126 mg per deciliter and a two-hour plasma glucose level of 140 to 200 mg per deciliter; type 2 diabetes was defined as a fasting glucose level of 126 mg per deciliter or higher or a two-hour plasma glucose level of more than 200 mg per deciliter. The prevalence of IGT is 13% in this study. The prevalence of IGT is 16.6% in overweight children and 7.5% in obese children. The prevalence of DM is 1%. Out 13 IGT children, 6 (11.6%) were boys and 7 (12.5%) were girls. Majority of the children with IGT were in 11-15 year age group. Impaired glucose tolerance is highly prevalent among children and adolescents with overweight and obesity.

KEYWORDS: Children, impaired glucose tolerance, obesity, type 2 diabetes.

INTRODUCTION

Obesity is defined as an excessive accumulation of adipose tissue containing stored fat in the form of triglycerides ^{[1], [2]}. The World Health Organization (WHO) ^{[3], [4]} describes obesity as one of today's most blatantly visible yet most neglected public health problems. The calculated global prevalence of overweight (including obesity) in children aged 5-17 years is estimated by the International Obesity Task Force (IOTF) to be approximately 10%, but this unequally distributed with the prevalence ranging from over 30% in America to <2% in Sub-Saharan Africa ^[5].

According to the WHO, more than 1.2 billion people worldwide are classified as overweight and 250 million are classified as obese. Worldwide, this is equivalent to 7 percent of the adult population ^[6]. Obesity is recognized as a major health problem in both developed and developing countries. In India, obesity is emerging as an important health problem.

The major health consequences associated with overweight and obesity are Type 2 diabetes, Coronary Heart Disease (CHD), hypertension, gall bladder disease, and certain types of cancer, dyslipidemia and insulin resistance ^[7]. Obesity and associated insulin resistance are considered the main risk factors for the developing type 2 diabetes mellitus (T2DM), regardless of genetic predisposition ^{[8], [9], [10]}. The current worldwide increase in obesity already in childhood is associated with an increase of T2DM and pre-diabetes defined as impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) ^[9]. Early identification of children and adolescents with IGT is beneficial for several reasons: we know that IGT in childhood predicts T2DM later in life ^{[11], [12]}. In adults, the progression from normal to impaired glucose tolerance and T2DM is caused by insulin resistance, followed by decreased β -cell insulin secreting capacity ^{[13], [14]}.

In adults, approximately 30% of patients with IGT will convert to T2DM within 5 years ^[15], ^[16]. Furthermore, children and adults with IGT have an increased risk of developing cardiovascular diseases prior to progressing to diabetes ^[17], ^[18], ^[19], ^[20]. Recently it has been shown that with changes in lifestyle the progression from impaired tolerance to type II diabetes can be prevented or delayed ^[21]. Therefore we investigated the prevalence of type 2 diabetes, impaired glucose tolerance in overweight and obese children. Based on these results the children are given advice regarding necessary lifestyle modifications.

MATERIALS AND METHODS

STUDY DESIGN: A Cross sectional study.

Study population consisted of 100 overweight and obese children (60 overweight and 40 obese children) in the age group of 5-15 years of either gender.

The study was approved by Institutional ethical committee of JSS Hospital, Mysore. Written informed consent was obtained from the parents and oral consent from the children. We prospectively examined 100 children and adolescents aged 5-15 years in two urban schools. A detailed medical and family history was obtained from all subjects, and physical examination was performed. All subjects were otherwise in good health. None of the children suffered from endocrine or syndromal disorders, or were on any medication. Ages of the children were taken from their school record; age at last birthday was recorded per subject. Degree of overweight and obese was derived from body mass index (BMI ^[22]). Body weight was measured with a digital scale to the nearest 0.1 kg with minimal clothing, and height was measured barefoot in triplicate with a wall-mounted stadiometer. The body mass index — the weight in kilograms divided by the square of the height in meters — was calculated. All subjects had a body-mass index that was higher than the 95th percentile for age and sex were

classified as obese and $>85^{\text{th}}$ and $<95^{\text{th}}$ as overweight²². All equipments were calibrated by biomedical engineering department as per standard operating procedures.

Blood sampling was performed in the fasting status. After the local application of spirit, one ante-cubital intravenous catheter was inserted for blood sampling. One base-line sample was then obtained for measurements of plasma glucose. Thereafter, flavored glucose, in a dose of 1.75 g per kilogram of body weight (up to a maximum of 75 g) was given orally, and blood samples were obtained after 120 minutes for the measurement of plasma glucose. Oral glucose tolerance test was performed in all children according to guidelines. Impaired fasting glucose (IFG) was defined as fasting serum glucose level of less than 126 mg per deciliter and a two-hour plasma glucose level of 140 to 200 mg per deciliter; type 2 diabetes was defined as a fasting glucose level of 126 mg per deciliter or higher or a two-hour plasma glucose level of more than 200 mg per deciliter [²³].

Diabetes was defined according to the guidelines of the American Diabetes Association. Glucose was measured by the glucose oxidase method on venous whole blood immediately de-proteinized with perchloric acid.

STATISTICAL ANALYSIS

All data were entered in a MS Excel sheet 2007. SPSS for windows Version-16 (2007) was employed for statistical analysis. Descriptive statistics were used to describe the data.

RESULTS

A total of 16.6% of overweight children and 7.5 % of obese children had impaired glucose tolerance. Silent diabetes was diagnosed in one child (1%). Among the children with impaired glucose tolerance, 6 (11.6%) were in boys and 7 (12.5%) were in girls. Majority of the children with IGT were in 11-15 year age group. The mean plasma glucose levels at 2 hours during the oral glucose tolerance test for overweight children with normal glucose tolerance were 80.26mg/dl and 119.9mg/dl with impaired glucose tolerance. Likewise with obese children, normal glucose tolerance was 78mg/dl and 117mg/dl with impaired glucose tolerance (Tab. 4). Mean BMI for the overweight and obese children were 21.7333 and 24.1900.

	SI	Total	
Age Group	Male Female		
5 10	30	16	46
5-10	48.4%	42.1%	46.0%
11 15	32	22	54
11-13	51.6%	57.9%	54.0%
Total	62	38	100

Table 1 Age and sex wise distribution of study sample

BMI CLASS	AGE G	Total	
Divit CLASS	5-10 Yr	11-15 Yr	Total
Over wt	19	41	60
Over wi	41.3%	75.9%	60.0%
Obese	27	13	40
obese	58.7%	24.1%	40.0%
Total	46	54	100

Table 2 Age group wise distribution of overweight and obese children

Table 3 Mean BMI values in overweight and obese children

BMI Class	Ν	Mean BMI
Over weight	60	21.7333
Obese	40	24.1900
Total	100	

Table 4 Mean FBS in over weight and obese children

BMI class	FBS	No	Mean (glucose value in mg/dl)
Over weight	Normal	51	81.03
	Impaired	8	116.6
	DM	1	146
Obese	Normal	37	78
	Impaired	3	117

BMI class	II class OGTT No		Mean (glucose value in mg/dl)		
Over weight	Normal	50	80.26		
Over weight	normai	50	00.20		
	Impaired	10	119.9		
Obese	Normal	37	78.0		
	Impaired	3	117		

Table 5 Mean OGTT in over weight and obese children

Table 6 Age wise distribution of impaired fasting glucose levels in over weight and obese

FBS Value	Age Group	Over Wt	Obese	Total
Normal	5-10	5-10 18 (30%)		44
	11-15	33(55%)	11(27.5%)	44
	Total	51	37	88
Impaired	5-10	0(0%)	1(2.5%)	1
	11-15	8(13.3%)	2(5%)	10
	Total	8	3	11
DM	5-10	1(1.66%)	0(0%)	1
	Total	60(100%)	40(100%)	100(100%)

children

Table 7 Age wise distribution of impaired glucose tolerance levels in over weight and

FBS Value	Age Group (yrs)	Over Wt	Obese	Total
Normal	5-10	18(30%)	26(65%)	44
	11-15	32(53.33%)	11(27.5%)	43
	Total	50(83.33%)	37(92.5%)	87
Impaired	5-10	1(1.66%)	1(2.5%)	2
11-15		9(15%)	2(5%)	11
Total		60(100%)	40(100%)	100

obese children

Table 8 Sex wise distributions of impaired fasting glucose (IFG) levels in over weight

and obese children

FBS Value	Sex	Over Wt	Obese	Total
Normal	Male	32(53.3%)	25(62.5%)	57
	Female	19(31.66%)	12(30%)	31
	Total	51(85%)	37(92.5%)	88
Impaired	Male	3(5%)	2(5%)	5
	Female	5(8.33%)	1(2.5%)	6
	Total	8(13.33%)	3(7.5%)	11
DM	Female	1(1.66%)	0	1
	Total	60(100%)	40(100%)	100(100%)

OGTT Value	Sex	Over Wt	Obese	Total
Normal	Male	31(51.66%)	25(62.5%)	56
	Female	19(31.66%)	12(30%)	31
	Total	50	37	87
Impaired	Male	4(6.66%)	2(5%)	6
	Female	6(10%)	1(2.5%)	7
	Total	60(100%)	40(100%)	100

Table 9 Sex wise distribution of impaired glucose tolerance levels (IGT) in overweight and obese children

DISCUSSION

Childhood obesity has reached epidemic proportions; worldwide, approximately 22 million children under five years are overweight ^[24]. Obesity has a substantial effect on cardiovascular risk. Childhood obesity is directly linked to abnormalities in blood pressure, lipid, lipoprotein and insulin levels in adults as well as to the risk of both coronary artery disease and diabetes ^[25]. Obese children have a higher prevalence of insulin resistance and diabetes. As the prevalence of childhood obesity increased between 1982 and 1994, the incidence of type 2 diabetes increased by nearly factor of 10, according to one report from Cincinnati ^[26]. The prevention and treatment of type 2 diabetes presents enormous challenge. The obvious way to prevent an epidemic of obesity related diabetes would be to emphasize the primary and secondary prevention of obesity. Given the observations of Sinha and coworkers, oral glucose tolerance testing appears to be an excellent method for identifying obese children who are at high for diabetes.

Impaired glucose tolerance is an intermediate category between normal glucose tolerance and overt diabetes and it can be identified by an oral glucose tolerance test ^{[27] [28]}. Subjects with impaired glucose tolerance have an increased risk of type 2 diabetes and therefore form an important target group for interventions aimed at preventing diabetes ^[29-31].

We present the results of a screening strategy using a 2 hour oral glucose tolerance test in a high risk cohort of overweight and obese children and adolescents. The optimal strategy and target population for type 2 diabetes screening remain controversial. We chose a target children with BMI > 85^{th} percentile for age and gender. Our objective was to identify the prevalence of impaired glucose tolerance in overweight and obese children.

In our study, 16.6% of overweight and 7.5% of obese children had impaired glucose tolerance. Silent diabetes was diagnosed in one child who was overweight.

In a study done by Sinha ^[32] et al., they determined the prevalence of impaired glucose tolerance in obese children, documenting IGT in 25 percent of 55 obese children (4-10 years of age) and in 21 percent of 112 obese adolescents (11 to 18 years). In addition, clinically asymptomatic or silent type 2 diabetes was uncovered in 4 of the 112 obese adolescents (4 percent). In study done by Desmond E Williams ^[33] et al., in the age group of 12-19 years, IFG was seen in 10% of boys and 4% of girls who are overweight.

In another study done Atabek³⁴ et al., in the age group of 7-18 years, out of 196 children, 15 (6.6%) of obese children had IFG and 35 (18%) of overweight children had IGT (Table 10).

Table 10.PREVALENCE OF IFG AND IGT IN OVER WEIGHT AND OBESE CHILDREN IN VARIOUS STUDIES

Sl No.	Study done by	Age gp (yrs)	Total	BMI Criteria	Prevalence of IFG		Prevalenc	ce of IGT	Prevalence	of DM
					OW	OB	OW	OB	OW	OB
1	Sinha et al., 2002 ^[32]	4-10	55	95 th centile -obese	-	25%	-	-	-	-
		11-18	112		-	21%		-	-	4 %
2	Desmond E Williams et al., ^[33] 1999-2000	12-19	915 417 - Boys 474 -Girls	OW- \geq 95 th centile At risk for OW \geq 85 th and <95 th centile	2.8% IFG - 10% (Boys) 4% (Girls)	17.8%	-	-	-	-
3	Atabek et al., [34]	7-18	196	SDS of BMI 2.17±0.03	-	15 (6.6%)	35 (18%)	-	-	3 %
4	Ramachandran et al 2003. ^[35]	≥20	-	-	-	8.7%	-	8.1%	- 13.9% 4 % DM – Us 27.1 % DM us	ing IFG sing IGT
5	Susanna wiegand et al., ^[36]	-	491	-	-	12 out of 491 patients	-	37 out of 491 patients	-	12 out of 491 patient s
6	Present study	5-15	100	$\geq 85^{\text{th}} \text{ and } < 95^{\text{th}} \text{ centile} - OW$ $\geq 95^{\text{th}} \text{ centile} - OB$	16.66%	7.5%	16.66%	7.5%	1.66 %	-

Keys: IFG – Impaired fasting glucose, IGT – Impaired glucose tolerance, OW – Over weight, OB – Obese, Yrs- Years

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CONCLUSION

Impaired glucose tolerance is an intermediate category between normal glucose tolerance and overt diabetes. Therefore it is better to screen the overweight and obese children with oral glucose tolerance test and follow up those children for the development of type 2 diabetes. Education regarding the lifestyle modifications can be given to prevent or prolong the development of type 2 diabetes.

LIST OF ABBREVIATIONS

IFG- Impaired Fasting Glucose IGT- Impaired Glucose Tolerance OGTT- Oral Glucose Tolerance FBS- Fasting Blood Sugar CHD- Coronary Heart Disease IOTF- International Obesity Task Force BMI- Body Mass Index T2DM- Type 2 Diabetes Mellitus ACKNOWLEDGEMENTS

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