Screening of Impaired Glucose Tolerance among Children and Adolescents with Observed Obesity in Mosul/Iraq

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Abstract
Impaired glucose tolerance (IGT) is recognized as the precursor of Type 2 diabetes and is more frequent in obese children and adolescents. **Objective:** In this research, we examined the prevalence of impaired glucose tolerance among obese children and adolescents. It is crucial to diagnose aberrant glucose metabolism as early as possible to prevent T2DM progression. **Methods:** Hospital-based research examined 163 obese kids and teens. A 2-hour oral glucose tolerance test (1.75 g. of glucose/kilogram of body weight) was done on all individuals. **Results:** 19.0% of children and 17.0% of adolescents had impaired glucose tolerance. This research showed 16.5% (n=16) of males and 19.7% (n=13) of females had IGT. In this investigation, systolic blood pressure, physical activity, LDL, total cholesterol, and acanthosis nigricans were strongly linked to decreased glucose tolerance ($p < 0.05$). **Conclusion:** Impaired glucose tolerance is quite frequent among obese children and adolescents, and it represents a major risk of diabetes.

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Introduction

A stage that occurs between normal glucose tolerance and diabetes is impaired glucose tolerance (IGT). Define blood sugar levels that are 140 mg/dl to 199 mg/dl (7.8 to 11.0 mmol/L) two hours after a meal. It is associated with the development of ischemic heart disease, diabetes mellitus, and cerebrovascular accidents, and is defined by hyperglycemia and insulin resistance [1]. Neurocognitive issues have also been reported. Normal glucose tolerance known as the absence of any symptoms of diabetes [2]. With diabetes being a chronic disorder that is associated with substantial morbidity and mortality [3].

The current global increase in pediatric obesity is linked to an increase in type-2 diabetes and prediabetes, also known as impaired glucose tolerance (IGT) [4]. Early diagnosis of IGT in children and adolescents is advantageous for many reasons: We are aware that early IGT predicts later T2DM [5]. In adulthood, the transformation from glucose tolerance to T2DM is frequently accompanied by impaired glucose tolerance [6]. Impairment of glucose tolerance is frequent among obese children and adolescents, as demonstrated by numerous descriptive cross-sectional studies [7]. This discovery highlights a correlation between obesity and severe insulin resistance, impaired glucose tolerance, pancreatic β-cell dysfunction, and a shift in the distribution of abdominal fat [8].

Due to an absence of awareness of IGT screening for obese children. The correlation between obesity and IGT has not been extensively studied in Iraqi children. This lack of awareness leads to undiagnosed diabetes developing in those who are obese. The importance of this study lies in its ability to detect children with IGT at an earlier stage, particularly those who are obese and have other risk factors. This might be of assistance to the patient in obtaining early medical treatment to avoid subsequent issues such as ischemic heart disease, diabetes, and cerebrovascular accidents [9].

Materials and Methods

From October 1, 2023, to May 2024, hospital-based research was carried out at Al-Wafaa Center in Mosul/Iraq.

The current investigation included 157 children and adolescents between the ages of 6 and 18 who were obese. All research participants underwent investigation for demographic parameters and anthropometric measures. Heights and weights are measured using a calibrated scale in the absence of footwear and bulky clothing. The precision of the height and weight measurements is 0.1 cm/0.1 kg. To identify obesity (BMI ≥ 95%), the CDC Growth chart was employed to calculate body mass index (BMI) by dividing weight (kg) by height squared (m^2) [10]. The obesity levels were categorized as follows: obese ≥ 95th, moderate obesity ≥ 98th, and severe obesity > 99^{th}. [11].

The questionnaires were specifically designed to collect information from participants regarding their family history of Type-2 Diabetes Mellitus, usage of glucocorticoid medication, maternal history of gestational diabetes during pregnancy, and level of physical activity (as defined by the World Health Organization (WHO), at least 30 minutes per day or 150 minutes per week). Furthermore, blood pressure (BP) was assessed for every participant. Prior to assessing blood pressure, the participants were instructed to rest for 10 minutes in a room climate-controlled environment. Resting in a supine posture, with the right arm extended. Systolic (SBP) and diastolic blood pressure (DBP) were measured using a calibrated sphygmomanometer. Hypertension was defined as SBP and/or DBP reaching or above the 95^{th} percentile [12]. The physician recognized the presence of acanthosis nigricans by examining the neck fold. Furthermore, the research included the documentation of fasting lipid profiles (including low density lipid (LDL), high density lipid (HDL), triglyceride (TG), and total cholesterol) for all included individuals.

Glucose measurements

The American Diabetes Association recognizes impaired glucose tolerance as a diagnostic acquired when the 2-hour oral glucose tolerance test (OGTT) runs from 140 mg/dl to 199 mg/dl, and diabetes as a diagnosis when the 2h-OGTT surpasses 200 mg/dl. [13]. After fasting overnight (810 hours), patients were given 1.75g of glucose/kg.bw orally (maximum 75g) in 250 cc of water for the oral glucose tolerance test (OGTT). Participants were instructed to stay still for two hours and just drink water. A food-fasting patient gave a baseline sample and a second 120 minutes later for the oral glucose tolerance test (OGTT) [14].

Statistical analysis

A collection of quantitative data was conducted using a questionnaire. Coding sheets are used to record the replies to questions. IBM SPSS 26 was utilized for statistical analysis. Basic statistical metrics of the data were provided, including percentage, frequency, mean, and standard deviations. A study of the Chi-square test was employed to determine the existence of a statistically significant difference for percentages in qualitative data. In statistical analysis, significance was determined when the p-value was equal to or less than 0.05.

Result

The characteristics of the 163 obese children and adolescents are documented in Table 1. Impaired glucose tolerance was found in 19% (n = 12) of 63 obese children (6–9 years) and 17.0% (n = 17) of 100 obese adolescents (10–18 years), while 3.0% (n=3) of adolescent were T2DM. 16.5% (n=16) of males with IGT and 19.7% (n=13) of females with IGT. In addition, this study found that 23.7% (n=18) of children and adolescents with a family history of T2DM had impaired glucose tolerance. Also, our study noted that 22.9% (n=22) of those who live a sedentary lifestyle were suffer from IGT. Regarding dyslipidemia, this study demonstrated that 25.4% (n=18), 33.3% (n=9), and 20.7% (n=6) from those with IGT had high LDL, cholesterol, and triglycerides, respectively. 23.3% (n=21) of obese children and adolescents with acanthosis nigricans were had IGT. However, the current study revealed that only systolic blood pressure, physical activity, LDL, total cholesterol, and presences of acanthosis nigricans were significantly associated with present impaired glucose tolerance Table 2.

Table 1: Distribution and association between glucose tolerance (GT) and related factors among obese children and adolescents

Variables		Normal Glucose Tolerance (NGT) N=131	Impaired glucose tolerance (IGT) N=29	Type-2 diabetes mellitus N=3	P. value
Age	Children	51 (81.0)	12 (10.0)	0 (0.0)	0.312
	Adolescents	80 (80.0)	17 (17.0)	3 (3.0)	
Gender	Male	79 (81.4)	16 (16.5)	2 (2.1)	0.732
	Female	52 (78.8)	13 (19.7)	1 (1.5)	
Address	Urban	94 (80.4)	21 (17.9)	2 (1.7)	0.353
	Rural	37 (80.4)	8 (17.4)	1 (2.2)	
Maternal history of GDM	Yes	22 (75.9)	6 (20.7)	1 (3.4)	0.321
	No	106 (81.5)	22 (16.9)	2 (1.6)	
	Unknown	3 (75.0)	1 (25.0)	0 (0.0)	
Family history of type 2 diabetes mellitus	Yes	56 (73.7)	18 (23.7)	2 (2.6)	0.347
	No	75 (86.2)	11 (12.6)	1 (1.2)	
Glucocorticoid medication use	Yes	32 (76.2)	10 (23.8)	0 (0.0)	0.431
	No	99 (81.8)	19 (15.7)	3 (2.5)	
Systolic blood pressure	Yes	28 (63.6)	13 (29.5)	3 (6.9)	0.007
	No	103 (86.6)	16 (13.4)	0 (0.0)	

* Significant difference between proportion Chi-square test at 0.05.

Table 2: The characteristics of **163** obese children and adolescents (data as range, mean ± SD)

Variables	Range	Mean	SD
Age (years)	6 – 18	11.57	3.29
Weight (kg)	29.0 - 121.0	67.14	20.89
Height (cm)	90 - 177	144.86	16.26
BMI (kg/m^2)	19.5 - 50.2	31.17	5.56
WC (cm)	69 - 124	93.46	11.79
Systolic BP (mmHg)	11 - 195	114.31	21.36
Diastolic BP (mmHg)	50 - 106	71.75	11.56
FBS (mg/dL)	69 - 140	97.82	11.05
2h-OGTT (mg/dL)	73 - 199	122.55	25.45
LDL-c (mg/dL)	12 - 166	96.26	26.45
HDL-c (mg/dL)	24 - 78	42.98	10.39
Total cholesterol (mg/dL)	88 - 237	153.34	26.57
Triglyceride (mg/dL)	28 - 302	105.95	53.68

Abbreviation: SD, standerd deviation; BMI: body mass index; WC: waist circumstance. Kg: kilograms. m², meter; BP, blood pressure; FBS, fasting blood sugar; 2h-OGTT, two-hour oral glucose tolerance test; LDL-C, low density lipoproteins cholesterol; HDL-c, high density lipoproteins cholesterol.

Figure (1) showed obese children and adolescents' NGT, IGT, and T2DM rates. The study found that 17.0% of obese children and adolescents had IGT, 81.0% had NGT, and 2.0% had type 2 diabetes. This IGT percentage is high. This is pre-diabetes. Obese children are more likely to develop type 2 diabetes (T2DM), hence abnormal glucose metabolism must be diagnosed early to prevent T2D. This suggests that obese children are more likely to develop type 2 diabetes.

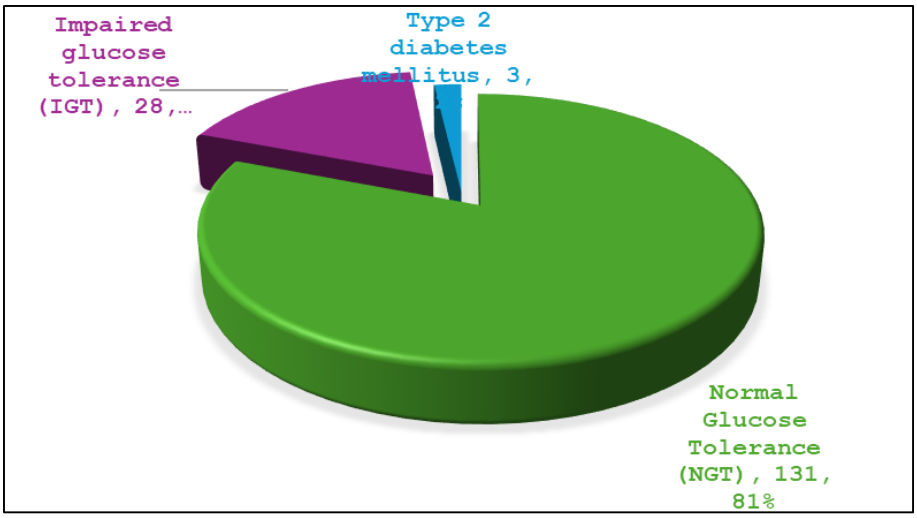

Fig 1: Explain the percentage of normal and impaired glucose tolerance and type-2 diabetes in obese children and obese adolescents

Figure (2) shows a relationship between glucose tolerance and degree of obesity. Where we noted that impaired fasting glucose and impaired glucose tolerance increases directly with the degree of obesity. This indicates that there is a strong relationship between glucose tolerance and obesity.

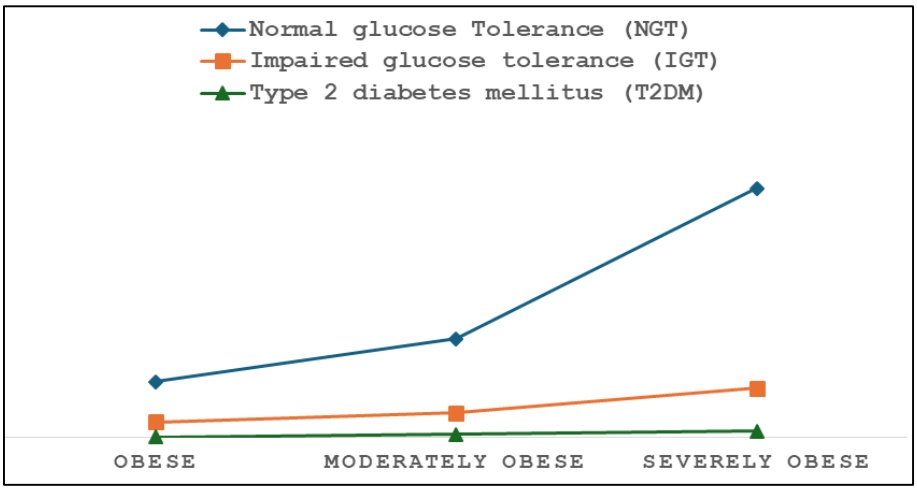

Fig 2: Distribution of glucose tolerance in children and adolescents according to the degree of obesity

Discussion

The study included a total of 163 children and adolescents with obesity. The present study detected that the proportion of IGT among obese children was 16.4% and among obese adolescents, it was 16.7%. Our results, when compared with a previous study by [15] are lower than the frequency of IGT reported, which found that 25% of children had IGT and 21% of adolescents had IGT. Physiologically, hepatic glucose production regulates glucose levels, whereas insulin levels indicate β-cell activity in reaction to blood glucose [16]. The IGT rate in obese children and adolescents was 16.5%, which is high. These findings suggest that IGT patients are at risk of developing type-2 diabetes without adopting a healthy lifestyle, including a regular exercise and balanced diet. Chronic diseases are metabolic changes that need a long-term lifestyle change [17]. Furthermore, females were more likely to have the IGT than men. This finding agreed with the outcome of a research by [1], which identified obese male (48.8%) and female (51.2%) patients. Feminine incidence may be greater owing to reduced insulin compassion due to more primeval fat than males, who deposit fat beneath the skin.

Furthermore, the current study found a significant association between glucose tolerance and physical exercise (p. value =0.027). In patients with poor glucose tolerance, physical activity (PA) has been shown effectively to minimize the risk of diabetes as well as cardiovascular disease [18]. In the present study, we revealed a significant link between systolic blood pressure (SBP) and glucose tolerance (p. value =0.005). This finding agreed with the finding of another study [19], which demonstrated a significant association between IGT\IFG and systolic BP. In terms of lipid profile, our study found a significant correlation between total cholesterol and LDL-c with GT (p. value <0.05). These results confirm the study by [20] done on children/adolescents with overweight and obesity in Italy, which shows that high LDL-c is significantly associated with impaired fasting glucose and impaired glucose tolerance. However, in obese people, the levels of triglycerides have been demonstrated to have a positive association with both the body mass index and the amount of fat in the body in most prior research [21]. In addition, our finding found significant linked between glucose tolerance and presences acanthosis nigricans. The presence of sign insulin resistance in obese children and adolescents suggests that they are at a higher risk of having serious consequences in adulthood [22].

Conclusion and recommendation

Impaired glucose tolerance occurs mostly in children and adolescents who are obese. As a result, it is critical to control obesity with appropriate methods such as food restriction, exercise, and medication to prevent the long-term health consequences associated with IGT such as type-2 diabetes mellitus.

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