University of Thi-Qar Journal of Science (UTJsci)
E-ISSN:2709-0256, P-ISSN: 1991-8690 Vol. (10), No.1(Special Issue: ISCAMET), April 2023

# Assessment of dietary patterns in obese children and adolescents at risk of pre-diabetes in Basra/Iraq

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***Abstract*— the role of nutrition in developing pre-diabetes among obese children and adolescents remains a major problem. Method: A cross-sectional study based on food frequency questionnaire data was conducted on obese children and adolescents aged 6–18 years at Al-Faiha Specialized Diabetes, Endocrine, and Metabolism Center (FDEMC) in Basra (South Iraq) from November 1, 2021, to the end of May 2022. This study aimed to assess dietary patterns for obese children and adolescents who are at risk for pre-diabetes. Results: 155 obese children and adolescents aged 6–18 years participated in the study, 60% of whom were males and 40% female. 40% (n=62) had Impaired fasting glucose (IFG), and 16.8% (n=26) had Impaired glucose tolerance (IGT). Regarding the dietary pattern, this study discovered that 58.7% (n=91) of the participants have a neutral eating habits score, followed by 40.0% (n=62) of them have an unhealthy eating habits score, while only 1.3% (n = 2) of participants have healthy eating habits. However, this study found significant static associations between dietary habits and education level, socio-economic status, and father education. Conclusion: Healthy eating habits, weight reduction, and increased physical activity are all factors that assist in preventing pre-diabetes and its complication such as type 2 diabetes mellitus.**

***Keywords*— *dietary habits, pre-diabetes, impaired fasting glucose, impaired glucose tolerance***

## I. INTRODUCTION

Pre-diabetes is a form of hyperglycemia that occurs when a person's glycemic indices are higher than normal but are not yet at the level that would be considered diabetes (1). It is referred to as impaired fasting glucose or impaired glucose tolerance (2). Pre-diabetes is a reversible condition of glucose irregularities that is often linked with obesity and other metabolic disorders (3). American Diabetes Association (ADA) used three criteria to diagnose prediabetes: a fasting blood glucose level from 100mg/dl to 125mg/dl, a hemoglobin A1c value from 5.7% to 6.4%, or a 2h-oral glucose tolerance test (OGTT) reading between 140mg/dl to199mg/dl (4).

Globally, the move from traditional, healthful, and natural diets to those heavy in fat, sugar, and salt has been observed in both developed and developing nations. This shift impacts people of all ages and communities, with the risk of obesity and chronic illnesses such as diabetes, hypertension, and stroke as a result (5).

Childhood obesity is one of the most serious public health issues facing the world today(6). Obesity and lifestyle habits of excessive food intake and increasing sedentary behaviors with decreased energy expenditure are the key modifiable risk factors for youth-onset type 2 diabetes, resulting in an excess of energy being stored as body fat. Chronic stress and/or low mood, as well as sleep-related problems, are all potentially modifiable risk factors for type 2 diabetes in adolescents and young adults (7). Individuals with diabetes often also have high blood pressure and high levels of cholesterol in their blood, all of which make the patient more likely to have a stroke (8).

In the last two decades, the prevalence of type 2 diabetes mellitus (T2DM) among children and adolescents has grown considerably across the world, particularly in developing countries. In both developed and developing nations, there has been an increase in the incidence of T2DM in children and adolescents (9). T2DM is more common in those who have metabolic syndrome, which included overweight or obese at a young age (10). In both children and adults, obesity is a key risk factor for T2DM. Type 2 diabetes mellitus was uncommon in children, but this has changed as a result of increased obesity, and a more sedentary lifestyle among children.

Any disruption in the body's structure or metabolism that causes a sustained alteration in a person's regular way of life is referred to as a chronic illness (11). In obese children, both insulin resistance and impaired insulin secretion occur very early and gradually lead to diabetes. As a consequence of increasing fatty deposits, primary obesity may produce hyperinsulinemia and insulin resistance. Up to 50% of obese children suffer from insulin resistance (12). In addition to other obesity-related comorbidities such as dyslipidemia, hypertension, musculoskeletal problems, fatty liver disease, and cardiovascular disease (13).

## II. MATERIALS AND METHOD

This cross-sectional study was conducted at Al-Faiha Specialize Diabetes, Endocrine, and Metabolism Center (FDEMC) in Basra (South Iraq) over a period from 1 November 2021 until the end of May 2022. Obese children and adolescents aged 6-18 years were selected from the children who came to FDEMC.

Previously established screening criteria have recommended that overweight (BMI ≥85th percentile) or obese (BMI ≥95th percentile) children and adolescents are considered at high risk for developing T2DM, in addition to other risk factors for diabetes (14). All participants were investigated with anthropometric measurements. Body-mass-index(BMI) was calculated from the ratio of the weight (kg) to the height squared (m2) and used BMI-for-age-sex percentiles to determine obesity (BMI ≥95th%) according to the CDC Growth chart (15).

The questionnaire was used to document the information from participants regarding demographic characteristics and family history of T2DM. Each participant was subjected to a general and physical examination. Appropriate cuff size was used to measure blood pressure (BP), before taking blood pressure, the participant was told to relax in an air-conditioned setting for at least 10 minutes. Systolic and diastolic BP was measured at the right-arm, in the supine position by using a calibrated sphygmomanometer. Blood pressure for the age-sex-height percentile was applied according to US guidelines for hypertension in children and adolescents, hypertension (SBP and/or DBP ≥95$^{th}$) (16). In addition, the fasting lipid profile (LDL, HDL, TG, and total cholesterol) was measured for all participants.

### *A. Assessment of the dietary habits*

The dietary habit of all children and adolescents was reported based on food frequency questionnaire data, which included the frequency of food intake of fresh fruit and raw vegetables, sweets, fast food, and soft drinks (stander 250 ml), and the number of meals per week for fish, meat, and legumes.

### *B. Glycemic measurement*

This study used ADA criteria to determine if a child have pre-diabetes. a fasting blood glucose level of 100mg/dl to 125mg/dl, an OGTT reading of 140mg/dl to 199mg/dl, or a hemoglobin A1c value of 5.7% to 6.4% (4). In the OGTT, participants were given 1.75g of glucose per kg of body weight orally (max-75g) in 250 ml of water after fasting overnight (8-10 hours). They were told to wait 2 hours without activity and no food or drink was allowed during the test except water. The OGTT was carried out by collecting a baseline sample from a fasting participant and a follow-up sample 120 minutes later (17).

### *C. Statistical Analysis*

The data of the study is shown as numbers and percentages were used. The Chi-square test was applied to see if there was a link between demographic characteristics and total eating habits score. Statistical significance was $P \leq 0.05$. IBM SPSS version 26 was used for entered and analyze the data. In Positive Phrases, the scale of the four levels was rated on the 4 points (Likert respondent scale) it was scored as scoring of agreed by assigning a score of (6) for “more than three time a week”, (5) for “three a week” , score of (4) for “twice a week”, the score of (3) for “once a week”, the score of (2) for “occasionally”, (1) for “NIL”. In Negative Phrases, the scale of the four levels was rated on the 4 points (Likert respondent scale) it was scored as scoring of agreed by assigning a score of (1) for “more than three times a week”, (2) for “three a week” , score of (3) for “twice a week”, the score of (4) for “once a week”, the score of (5) for “occasionally”, (6) for “NIL”. The questions regarding dietary habits” were 8 questions so the Minimum Score= 8, Maximum Score= 48, and the Median Score = 28. A score of more than 75% was considered good "Healthy eating habits" (>38 scores), 50-74% acceptable/fair "Neutral eating habits" (28-38 score), and less than 50% was taken as poor "Unhealthy eating habits" (<28 scores).

## III. RESULTS

This study included 155 obese children and adolescents aged 6-18 years with a mean age 11.60±3.27 years. The maximum number of 47.1% (n=73) of participants belonged to the 10–13 years. 60% (n=93) were males, while 40% (n=62) were females. Regarding education, most participants 60.6% (n=94) were at primary stage, but regarding education level of the father/mother, this study demonstrated that large proportion 36.8% (n=57) of fathers had university education, in contrast, high percentage of mothers illiterate. Those covariates regarded as possible confounders in the current study were theoretically or empirically linked to the misuse and risk of pre-diabetes. Also, 75.5% (n=117) of participants were from urban areas, and 53.5% (n=83) had a medium socioeconomic status, followed by 45.2% (n=70) had a low socioeconomic status. Moreover, a very small percentage 1.3% (n=2) of the study participants had a high socio-economic status, but most of them were in medium and low socio-economic.

**Table (1)** Distribution of the studied sample according to demographic characteristics

| Variables | Categories | No | % |
|---|---|---|---|
| **Age groups** | 6-9 years | 37 | 23.9 |
| | 10-13 years | 73 | 47.1 |
| | 14-18 years | 45 | 29.0 |
| | Mean± SD | 11.60±3.27 | |

| | | | | | |
|---|---|---|---|---|---|
| **Gender** | Male | | 93 | | 60.0 |
| | Female | | 62 | | 40.0 |
| **Residence** | Urban | | 117 | | 75.5 |
| | Rural | | 38 | | 24.5 |
| **Education** | Primary stage | | 94 | | 60.6 |
| | Secondary stage | | 57 | | 36.8 |
| | Illiterate | | 4 | | 2.6 |
| **Father education** | Illiterate | | 15 | | 9.7 |
| | Primary | | 36 | | 23.2 |
| | Secondary | | 47 | | 30.3 |
| | University or high | | 57 | | 36.8 |
| **Mother education** | Illiterate | | 39 | | 25.2 |
| | Primary | | 41 | | 26.5 |
| | Secondary | | 37 | | 23.9 |
| | University or high | | 38 | | 24.5 |
| **Socio-economic status** | Low | | 70 | | 45.2 |
| | Medium | | 83 | | 53.5 |
| | High | | 2 | | 1.3 |

**Figure 1** shows that 40% of the participants had prediabetes by FBS test (impaired fasting glucose), 16.8% had prediabetes by 2h-OGTT (Impaired glucose tolerance), and 37.4% were prediabetes according to HbA1c test. This proportion differed from one research to another. This difference might be related to the type of methods or criteria utilized in these studies as well as the characteristics of the participants.

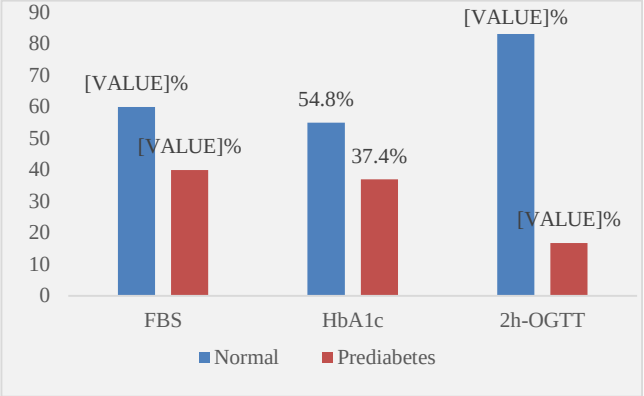


**Figure 1:** Distribution of the studied sample according to glycemic status

In our study, **Table 2** showed the association between impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) with other related factors (such as gender, family history of T2DM, physical exercise, and other metabolic disorder). However, the IFG was more occurs in males 41.9% (n=39) than in females 37.1% (n=23), while IGT was more occur in females 19.4% (n=12). This differences in incidence is due to different insulin sensitivity as a result of more visceral fat, which stores fat under the skin. Also, this study found that most of those who had a family history of T2DM and had a sedentary lifestyle had IFG and IGT

**Table 2:** The distribution of characteristics related to IFG ana IGT among 155 obese children and adolescents .

| | | **Impaired fasting glucose (IFG)** | | ***P.value*** | **Impaired glucose tolerance (IGT)** | | ***P.value*** |
|---|---|---|---|---|---|---|---|
| | | **No (n=93)** | **Yes (n=62)** | | **No (n=129)** | **Yes (n=26)** | |
| **Gender** | Male | 54 (58.1%) | 39 (41.9%) | 0.547 | 79 (84.9%) | 14 (15.1%) | 0.483 |
| | Female | 39 (62.9%) | 23 (37.1%) | | 50 (80.6%) | 12 (19.4%) | |
| **Family history of T2DM** | Yes | 32 (42.7%) | 43 (57.3%) | **<0.001*** | 59 (78.7%) | 16(21.3%) | 0.141 |
| | No | 61 (76.3%) | 19 (23.8%) | | 70 (87.5%) | 10 (12.5%) | |
| **Physical exercise** | Yes | 45 (75.0%) | 15(25.0%) | **0.002*** | 56 (93.3%) | 4 (6.7%) | **0.008**** |
| | No | 48 (50.5%) | 47(49.5%) | | 73 (76.8%) | 22 (23.2%) | |
| **Hypertension** | Yes | 28 (48.3%) | 30(51.7%) | **0.021*** | 42 (72.4%) | 16() 27.6% | **0.005*** |
| | No | 65 (67.0%) | 32(33.0%) | | 87 (89.7%) | 10 (10.3%) | |
| **Low density lipoprotein** | Normal | 56 (65.9%) | 29(34.1%) | 0.09 | 77 (90.6%) | 8 (9.4%) | **0.007*** |
| | High | 37 (52.9%) | 33 (47.1%) | | 52 (74.3%) | 18 (25.7%) | |
| **High density lipoprotein** | Low | 34 (54.0%) | 29 (46.0%) | 0.411 | 53 (84.1%) | 10 (15.9%) | 0.945 |
| | Normal | 54(63.5%) | 31(36.5%) | | 70 (82.4%) | 15 (17.6%) | |
| | High | 5 (71.4%) | 2 (28.6%) | | 6 (85.7%) | 1 (14.3%) | |
| **Total cholesterol (TC)** | Normal | 76 (58.9%) | 53 (41.1%) | 0.539 | 112 (86.8%) | 17(13.2%) | **0.008*** |
| | High | 17 (65.4%) | 9 (34.6%) | | 17 (65.4%) | 9 (34.6%) | |
| **Triglyceride** | Normal | 81(64.3%) | 45 (35.7%) | 0.023* | 106 (84.1%) | 20 (15.9%) | 0.531 |
| | High | 12 (41.4%) | 17 (58.6%) | | 23 (79.3%) | 6 (20.7%) | |

**Significant difference between proportions using Pearson Chi-square test at 0.05 level*

***For cell have expected count less than 5, we used Fisher's Exact Test at 0.05 level.*

**Figure 2** reveals that 91 (58.7%) of the participants have neutral eating habits scores followed by 62 (40.0%) of them have unhealthy eating habits scores. While only 2 (1.3%) of the participants have healthy eating habits score. This

indicates that most children with obesity do not follow a healthy diet. This condition increases their chance of developing prediabetes or type 2 diabetes in adulthood unless applying a healthy lifestyle.

Although there were several studies analyzing the dietary patterns of children and adolescents, the majority of the studies have been conducted in Western countries, such as Europe and Australia, and it is known that they primarily show a relationship between the Westernized dietary pattern and obesity (18,19). There has been little investigation into the links between dietary patterns and obesity-related metabolic disorders in children and adolescents, particularly in Asian nations. However, children with obesity must follow a healthy diet in order to prevent obesity and its complications such as type 2 diabetes and heart disease in adulthood.

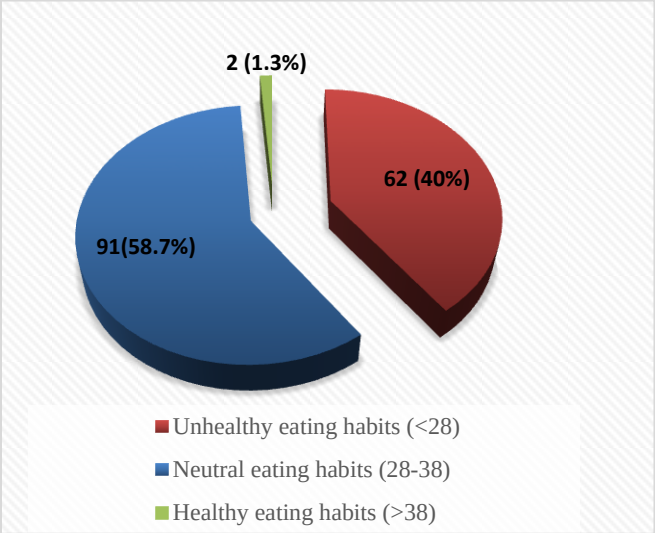


**Figure 2:** represents the overall eating habits score for study sample

**Table 3** showed that there was no statically significant association between total eating habits score and socio-demographic characteristics of the studied sample (P. value >0.05), except the education level of participants, level education of father, and Socio-economic status have a significant association with total eating habits score (p. value <0.05). In this study, we found that the participants who were in primary stage of education and illiterate have unhealthy eating habits more than those who were in secondary stage of education. This indicates that the education level of participants had positive affect in choosing healthy diet.

While 54.4% of participants whose their fathers were at university or high educational level have unhealthy eating habits compared with those whose their fathers have lowest education level. The possible explanation for this result may be due to the preoccupation of some parents with studies or work, which leads to a low level of follow-up for their children in choosing the types of foods and applying healthy lifestyle.

Regarding socio-economic status, the results of this study indicate that 100.0% of the participants who high income levels have unhealthy eating habits more than those who participants have other levels. The possible explanation for this result may be due to the ease of purchasing most types of healthy and unhealthy foods as a result of the availability of sufficient funds.

**Table (3):** Association between total eating habits score and socio-demographic characteristics of the studied sample

| | **Total eating habits score** | |
|---|---|---|

| | | Unhealthy eating habits (<28) | Neutral eating habits (28-38) | Healthy eating habits (>38) | |
|---|---|---|---|---|---|
| **Age groups** | 6-9 years | 20 (54.1%) | 17 (45.9%) | 0 (0.0%) | 0.085 |
| | 10-13 years | 31 (42.5%) | 41 (56.2%) | 1 (1.4%) | |
| | 14-18 years | 11 (24.4%) | 33 (73.3%) | 1 (2.2%) | |
| **Gender** | Male | 32 (34.4%) | 59 (63.4%) | 2 (2.2%) | 0.133 |
| | Female | 30 (48.4%) | 32 (51.6%) | 0 (0.0%) | |
| **Residence** | Urban | 48 (41.0%) | 67 (57.3%) | 2 (1.7%) | 0.624 |
| | Rural | 14 (36.8%) | 24 (63.2%) | 0 (0.0%) | |
| **Education** | Primary stage | 48 (51.1%) | 45 (47.9%) | 1 (1.1%) | **0.009*** |
| | Secondary stage | 12 (21.1%) | 44 (77.2%) | 1 (1.8%) | |
| | Illiterate | 2 (50.0%) | 2 (50.0%) | 0 (0.0%) | |
| **Level education of father** | Illiterate | 2 (13.3%) | 13 (86.7%) | 0 (0.0%) | **0.022*** |
| | Primary | 12 (33.3%) | 24 (66.7%) | 0 (0.0%) | |
| | Secondary | 17 (36.2%) | 28 (59.6%) | 2 (4.3%) | |
| | University or high | 31 (54.4%) | 26 (45.6%) | 0 (0.0%) | |
| **Level education of mother** | Illiterate | 16 (41.0%) | 23 (59.0%) | 0 (0.0%) | 0.653 |
| | Primary | 13 (31.7%) | 28 (68.3%) | 0 (0.0%) | |
| | Secondary | 16 (43.2%) | 20 (54.1%) | 1 (2.7%) | |
| | University or high | 17 (44.7%) | 20 (52.6%) | 1 (2.6%) | |
| **Socio-economic status** | Low | 21 (30.0%) | 49 (70.0%) | 0 (0.0%) | **0.042*** |
| | Medium | 39 (47.0%) | 42 (50.6%) | 2 (2.4%) | |
| | High | 2 (100.0%) | 0(0.0%) | 0 (0.0%) | |

**Significant difference between proportions using Pearson Chi-square test at 0.05 level*

## IV. DISCUSSION

In this study, we identified that a very small percentage 1.3% of children had a healthy eating pattern, while 40% of the participants in the study had an unhealthy eating pattern; in contrast, 58.7% of them had neutral dietary habits. This result confirms a study in Tbilisi (20), which revealed that dietary habits of school-age children are unhealthy. High consumption of saturated fat and carbohydrates (e.g., sweets, fast meals, and soft drinks) increases the risk of obesity and its consequences in children and adolescents (21). In other directions, a diet high in vegetables and fruits has been linked to a lower prevalence of obesity (22). However, obese children with pre-diabetes should follow a healthy lifestyle (healthy diet and Physical activity) in order to prevent progression to T2DM.

In addition, this study found that a considerable proportion of 40% from obese children and adolescents had impaired fasting glucose (IFG). also, 16.8% had impaired glucose tolerance. In general, these proportions are relatively high. This indicates those with IFG or IGT are at high risk of progression to type-2 diabetes mellitus unless they apply a healthy lifestyle such as a healthy diet and physical activity to reduce or prevent the progression to T2DM. Our results when compared with the results of the study (23) among overweight and obese adolescents in the US was higher, this may be because the study group were obese only. Which found that the prevalence of IFG among US adolescents was 17.8%. while the study (24) in The United Arab Emirates showed 5.4% of Emirati overweight/obese children and adolescents were pre-diabetic according to IGT. Most participants with IFG were males, while most participants with IGT were females. Similar results were shown from the findings of study in Mauritius (25), which revealed that men were twice as likely as women to have IFG, while IGT was lower in men. This observation raises critical issues regarding their underlying etiology and the efficacy of existing glucose thresholds to identify males and females at equal risk of acquiring diabetes. IFG should be viewed as a complement to abnormal glucose tolerance rather than a substitute for IGT. However, this difference in the incidence may be due to different insulin sensitivity because of more visceral fat, which stores fat under the skin.

Our findings, showed a significant static association between IFG and family history of T2DM, physical activity, and hypertension, in contrast, the IGT was significantly associated with physical activity, hypertension, LDL, and total cholesterol (p.value<0.05). while a study (26) don among Obese Youth, found that IGT was significantly linked with triglycerides and HDL-c.

This study found significant associations between dietary habits and a participant's education level (p.value= 0.009). This result discovered that those in the second stage were healthier eating pattern compared to those in the primary stage. This reflects that they were more knowledgeable compared to those in the primary stage. Also, the current study revealed that the father education and socioeconomic status were significantly related to children dietary patterns. This finding confirms the outcomes of the study (27), which indicate that parental socio-demographic variables, such as education and occupation, as well as diet knowledge and lifestyle, have a good influence on children's eating behaviors and lifestyles. Every parent wants their children to be healthy, should be provide them with healthy meals.

However, this study may have been faced with a number of limitations. Because it was a cross-sectional study, it is unable to determine if food patterns are related to insulin resistance, metabolic syndrome, and other indications. Second, there was a possibility of underreporting nutritional consumption in obese and extremely obese patients.

## V. Conclusion and Recommendation

Pre-diabetes (IFG or IGT) were relatively high among obese children and adolescents, as well as a very small percentage of them had a healthy diet pattern. Healthy eating habits, weight reduction, and increased physical activity all are factors that assist in preventing pre-diabetes and its complication such as type 2 diabetes mellitus.

## ACKNOWLEDGMENT

We are deeply grateful to all staff of Al-Faiha Specialized Diabetes, Endocrine, and Metabolism Center (FDEMC) in Basra province.

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