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RISK FACTORS OF PREDIABETES IN CHILDREN AGED (5-14) YEARS IN NINEVEH GOVERNORATE A CASE-CONTROL STUDY

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ABSTRACT

Prediabetes is an increasing public health concern among children because of its potential progression to type 2 diabetes mellitus. This study aimed to identify the major risk factors associated with prediabetes among children aged 5–14 years in Nineveh Governorate, Iraq. A hospital-based case-control study was conducted at Al-Khansa Hospital, Mosul, involving 150 children, including 50 diagnosed with prediabetes and 100 healthy controls. Data on sociodemographic characteristics, family and medical history, dietary habits, and physical activity were collected using structured questionnaires. Statistical analysis was performed using IBM SPSS version 26, and associations were evaluated using Chi-square tests and odds ratios (ORs). Prediabetes was significantly associated with lower paternal education (OR=8.57), obesity (BMI percentile ≥95th; OR=14.40), hypercholesterolemia (OR=51.00), family history of diabetes in grandparents (OR=6.13), maternal obesity (OR=12.50), frequent consumption of sugary drinks (OR=107.20) and fast food (OR=104.10), and lack of regular physical activity (OR=14.33) (all P<0.01). In contrast, regular vegetable consumption (OR=0.25) and participation in sports for 1–<3 days per week (OR=0.10) were identified as protective factors. These findings indicate that childhood prediabetes is strongly associated with obesity, adverse family history, unhealthy dietary patterns, and physical inactivity, highlighting the need for early lifestyle-based interventions to reduce the risk of progression to type 2 diabetes and support effective prevention strategies in Iraqi children

KEYWORD: Prediabetes; Children; Risk factors; Obesity; Dietary habits; Physical activity.

1. INTRODUCTION

Prediabetes is an intermediate metabolic state characterized by blood glucose levels above normal but below the diagnostic threshold for type 2 diabetes mellitus (T2DM).[1,2] It is increasingly recognized as a major public health concern among children because it represents an early stage of glucose dysregulation that may progress to diabetes and its long-term complications if left untreated. Over the past two decades, the global increase in childhood obesity, sedentary lifestyles,[3] and unhealthy dietary habits has been accompanied by a marked rise in the prevalence of pediatric prediabetes. Early-onset dysglycemia is associated with prolonged exposure to hyperglycemia, increasing the lifetime risk of cardiovascular disease, nephropathy, neuropathy, and other metabolic disorders.[4]

The development of prediabetes in children is multifactorial, resulting from interactions between genetic susceptibility, environmental influences, and lifestyle behaviors.[5][6] Obesity, particularly central obesity, insulin resistance, dyslipidemia, family history of diabetes, unhealthy dietary patterns, and physical inactivity are among the most consistently reported risk factors.

Socioeconomic characteristics and parental education may also influence disease risk through their effects on nutrition, health awareness, and access to preventive healthcare. Identifying these modifiable risk factors is essential for implementing effective prevention programs and reducing the progression to T2DM.[7,8]

1.4 Aim of the Study

The study aims to evaluate the main risk factors for prediabetic children (5-14) years in Nineveh.

1.5 Specific Objectives

1. To describe the sociodemographic characteristics of the study population.
2. To identify the effect of overweight and obesity (BMI) on prediabetic children.
3. To assess the association between family history of type 2 diabetes and prediabetes in children.
4. To analyze the influence of dietary habits (consumption of fast food, sugary beverages, fruits, and vegetables) on prediabetes risk.
5. To examine the role of physical activity level and sedentary behavior (screen time, TV and video games) in the development of prediabetes.

2. PATIENTS AND METHODS

2.1 Administrative agreement

The official approval has been obtained from the Arab Board of Health Specializations, and the official approval of the Nineveh health directorate was obtained before the beginning of data collection. The administration of Al-Khansaa Teaching Hospitals was informed about the nature of the study, and written consent was obtained from them before participation and before filling out the questionnaire. Verbal consent from each parent participating in this research has been obtained.

2.2 Ethical consideration

The investigator interviewed all caregivers to explain the study's objectives and obtain verbal consent before data collection. Data collection will be kept confidential and not divulged except for study purposes.[9]

2.3 Study Setting and Design

This hospital-based analytical case-control study was conducted in Mosul City, the center of Nineveh Governorate in northwestern Iraq, and the country's second-largest city after Baghdad. The study was carried out at the endocrine consultation units of Al-Khansa Teaching Hospital, where children aged 5–14 years attending the clinic were recruited. Data were collected from the children's caregivers using a structured questionnaire to achieve the study objectives.

2.4 Study Period and Participants

Data were collected over six months (February–June 2025) through 2–3 weekly visits to the endocrine consultation units at Al-Khansa Teaching Hospital. The study included 150 children aged 5–14 years: 50 children diagnosed with prediabetes based on clinical assessment and HbA1c levels of 5.7%–6.4% (cases), and 100 age-matched children with normal HbA1c levels and no diagnosis of prediabetes (controls). Controls were recruited from the endocrine consultation unit or other hospital departments and included children with conditions unrelated to glucose metabolism.

2.5 Eligibility Criteria and Pilot Study

Children of both sexes aged 5–14 years attending Al-Khansa Teaching Hospital whose caregivers provided informed consent were eligible for inclusion. Children with type 1 diabetes mellitus, conditions affecting HbA1c measurements (e.g., sickle cell disease, thalassemia, chronic renal or liver disease), those younger than 5 or older than 14 years, and those whose caregivers declined participation were excluded.

A pilot study involving 15 children (5 cases and 10 controls) was conducted over two weeks to evaluate the clarity and completeness of the questionnaire, identify potential challenges during data collection, and assess caregivers' cooperation. The pilot achieved an 86.7% response rate; non-response was due to parental refusal of diabetes screening. Minor revisions were made to simplify questions related to dietary habits and physical Recalling these details. Pilot participants were excluded from the final analysis.

3. Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 26. Descriptive statistics were used to summarize the study variables. Associations between cases and controls were evaluated using the Chi-square test or Fisher's exact test, as appropriate. Odds ratios (ORs) with 95% confidence intervals (95% CIs) were calculated to estimate the strength of association between potential risk factors and prediabetes. A two-tailed P value <0.05 was considered statistically significant.[10]

Table 1: Two-by-Two Contingency Table for Odds Ratio (OR) Analysis.

	Cases	Control
Risk factor present (exposed)	a	b
Risk factors absent (unexposed)	c	d

3.1 Data Collection Tool

Data were collected using a structured questionnaire specifically designed for this study. The questionnaire consisted of five sections covering:

(1) sociodemographic characteristics (child's age, sex, parental education, and BMI-for-age according to the Centers for Disease Control and Prevention growth charts); (2) family history of diabetes mellitus and obesity; (3) medical history, including obesity, hypertension, hypercholesterolemia, heart disease, and other chronic conditions; (4) dietary habits, including the consumption of sugary drinks, sweets, fast food, fruits, and vegetables; and (5) lifestyle factors, including participation in physical activity and daily screen time.

4. RESULTS

The study included 150 children aged 5–14 years, comprising 50 cases with prediabetes and 100 healthy controls. The results are presented according to the main study variables, including sociodemographic

characteristics, family and medical history, dietary habits, and physical activity, with statistically significant associations reported where applicable.

4.1 Sociodemographic Characteristics

Table 2 summarizes the sociodemographic characteristics of the study participants. No significant associations were observed between prediabetes and children's sex, age group, or maternal employment (P>0.05). In contrast, lower paternal educational level, particularly primary and secondary education, was significantly associated with prediabetes, whereas paternal college education showed a protective association. Primary maternal education was also significantly associated with prediabetes, while secondary and college education were not. In addition, overweight (85th–<95th percentile) and obesity (≥95th percentile) based on BMI-for-age were significantly associated with prediabetes, whereas underweight (<5th percentile) showed on (Table 2).

Table 2: Socio-demographic characteristics of the study sample.

Characteristic	Cases = 50		Control = 100		Total = 150		P-value*	Odd ratio	C.I 95%
	No.	%	No.	%	No.	%			
Gender									
Male	23	46.0	50	50.0	73	48.7	0.644	0.852	0.431 : 1.682
Female	27	54.0	50	50.0	77	51.3			
Age in years									
5-<10	9	18.0	27	27.0	36	24.0	0.224	0.593	0.255 : 1.383
10-14	41	82.0	73	73.0	114	76.0			
Father education									
Primary school	10	20.0	0	0.0	10	6.7	<0.001**		
Secondary school	31	62.0	16	16.0	47	31.3	<0.001	8.566	3.918 : 18.72
College	9	18.0	84	84.0	93	62.0	<0.001	0.042	0.017 : 0.103
Mother education									
Primary school	9	18.0	0	0.0	9	6.0	<0.001**		
Secondary school	13	26.0	16	16.0	29	19.3	0.144	1.845	0.806 : 4.221
College	28	56.0	84	84.0	112	74.7	<0.001	0.242	0.112 : 0.525
Does the mother Employee?									
Yes	28	56.0	62	62.0	90	60.0	0.480	0.780	0.392 : 1.554
No	22	44.0	38	38.0	60	40.0			
BMI for age percentile									
< 5 th percentile	1	2.0	7	7.0	8	5.3	0.270**	1.83	0.19 : 17.9
5th-<85th percentile (ref)***	5	10.0	64	64.0	69	46.0	------	------	-----
85th-<95th percentile	17	26.0	5	5.0	22	14.7	0.001	43.56	11.22 : 169.6
≥ 95th percentile	27	54.0	24	24.0	51	34.0	0.001	14.4	4.97 : 41.70

using X^2 test ** using fisher exact test ***using reference group

4.2 Family History of Diabetes and Obesity

Table 3 presents the association between family history and prediabetes. A family history of diabetes in the father and grandparents was significantly associated with an increased risk of prediabetes, whereas a maternal history of diabetes showed no significant association. Similarly, a family history of obesity in the mother, father, and grandparents was significantly associated with prediabetes. In contrast, the absence of a family history of diabetes or obesity was associated with a significantly lower risk of prediabetes (Table 3).

4.3 Medical History

Table 4 shows the association between medical history and prediabetes. Childhood obesity, hypercholesterolemia, and chronic conditions (thyroid and hormonal disorders) were significantly associated with prediabetes. In contrast, no significant association was observed for heart disease, while no cases of hypertension were reported in either group (Table 4).

Table 3: Family history in the study group

Family history	Cases = 50		Control = 100		Total = 150		P-value*	Odd ratio	C.I. 95%
	No.	%	No.	%	No.	%			
History of DM									
Mother	2	4.0	1	1.0	3	2.0	0.258**	4.125	0.365 : 46.62
Father	10	20.0	1	1.0	11	7.3	0.001	24.75	3.067 : 199.7
Grandp arents	31	62.0	21	21.0	52	34.7	0.001	6.138	2.909 : 12.95
None	7	14.0	77	77.0	84	56.0	0.001	0.049	0.019 : 0.123
History of obesity									

Mother	14	28.0	3	3.0	17	11.3	0.001	12.574	3.412 : 46.33
Father	5	10.0	2	2.0	7	4.7	0.041**	5.444	1.017 : 29.13
Siblings	1	2.0	0	0.0	1	0.7	0.333**		
Grandp arents	11	22.0	2	2.0	13	8.7	<0.001**	13.82	2.929 : 65.22
None	19	38.0	93	93.0	112	74.7	0.001	0.046	0.018 : 0.120
*using X^2 test ** using fisher exact test									

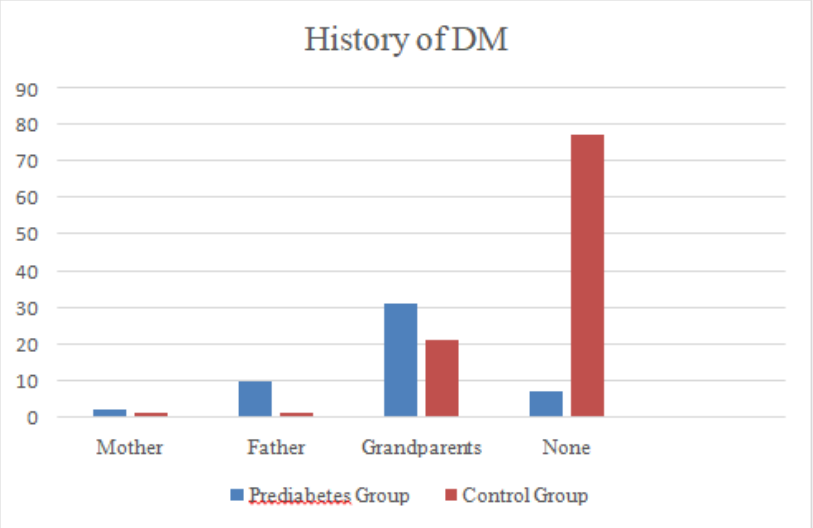

Figure 1: Family history of DM among the study sample.

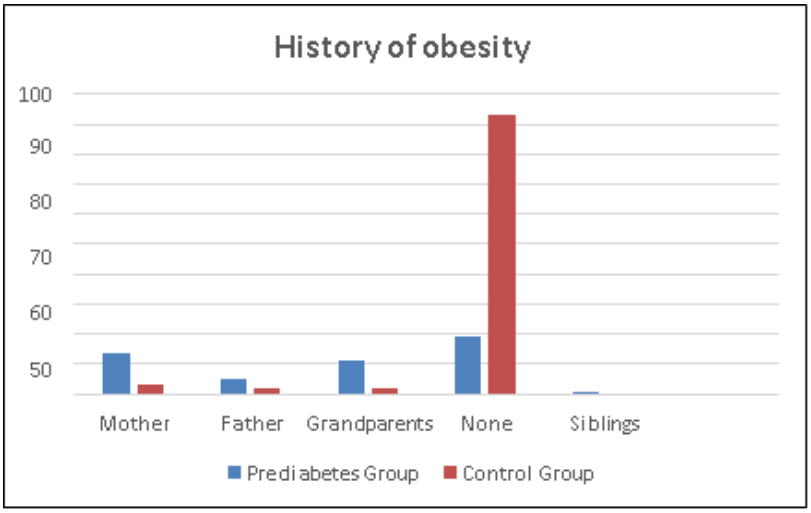

Figure 2: Family history of obesity among the study sample.

Table 4: Related health and medical history among the study sample.									
Has the child had?	Cases = 50		Control = 100		Total= 150		P-Value	Odd ratio	C.I. 95%
	No.	%	No.	%	No.	%			
Obesity									
Yes	27	54.0	24	24.0	51	34.0	<0.001	3.72	1.83: 7.56
No	23	46.0	76	23.0	99	66.0			
High blood pressure									
Yes	0	0.0	0	0.0	0	0.0			
No	50	100.0	100	100.0	150	100.0			
High cholesterol									
Yes	17	34.0	1	1.0	18	12.0	<0.001	51.000	6.533: 398
No	33	66.0	99	99.0	132	88.0			
Heart disease									
Yes	3	6.0	1	1.0	4	2.7	0.108**	6,319	0.640:

No	47	94.0	99	99.0	146	97.3			62.37
Any chronic condition (thyroid and hormonal imbalance)									
Yes	5	10.0	0	0.0	5	3.3	0.004**		
No	45	90.0	100	100.0	145	96.7			
***Using X^2 test **using fisher exact test**									

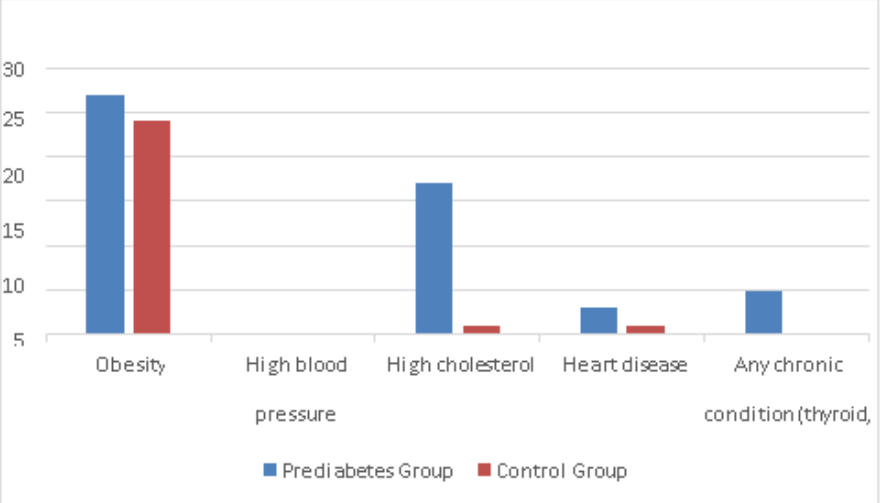

Figure 3: Related health and medical history among the study sample.

4.4 Dietary Habits

Table 5 presents the association between dietary habits and prediabetes. Frequent consumption of sugary drinks, sweets, and fast food was significantly associated with an increased risk of prediabetes, with the risk increasing as consumption frequency increased. Conversely, regular consumption of vegetables showed a significant protective association. Fruit consumption was also associated with a lower risk of prediabetes (Table 5).

4.5 Physical Activity

Table 6 shows the association between physical activity and prediabetes. Children who did not participate in regular sports had a significantly higher risk of prediabetes, whereas participation in sports for 1–<3 days per week was associated with a lower risk. In addition, prolonged daily screen time was significantly associated with prediabetes, with the risk increasing as screen time increased (Table 6).

Table 5: Dietary habits among the study sample									
Dietary habits:	Cases = 50		Control = 100		Total= 150		P Value*	Odd ratio	C.I. 95%
	No.	%	No.	%	No.	%			
Consume sugary drinks and sweets.									
Never	0	0.0	28	28.0	28	18.7	<0.001		
Once weekly	1	2.0	67	67.0	68	45.3	<0.001	0.010	0.001 : 0.076
2-4 times weekly	23	46.0	4	4.0	27	18.0	<0.001	20.444	6.510 : 64.20
≥ 5 per week	26	52.0	1	1.0	27	18.0	<0.001	107.2	13.85 : 830.1
Consume fast food and high in fat and oil.									
Never	1	2.0	29	29.0	30	20.0	<0.001	0.050	0.007 : 0.379
Once weekly	12	24.0	69	69.0	81	54.0	<0.001	0.142	0.065 : 0.308
2-4 times weekly	34	68.0	2	2.0	36	24.0	<0.001	104.1	22.75 : 476.4
≥ 5 per week	3	6.0	0	0.0	3	2.0	0.036 **		
Children eat fruits									
Yes	21	42.0	69	69.0	90	60.0	0.001	0.325	0.161 : 0.657
No	29	58.0	31	31.0	60	40.0			
Child eats vegetables									
Yes	22	44.0	76	76.0	98	65.0	<0.001	0.248	0.120: 0.511
No	28	56.0	24	24.0	52	35.0			
***Using X^2 test **using fisher exact test**									

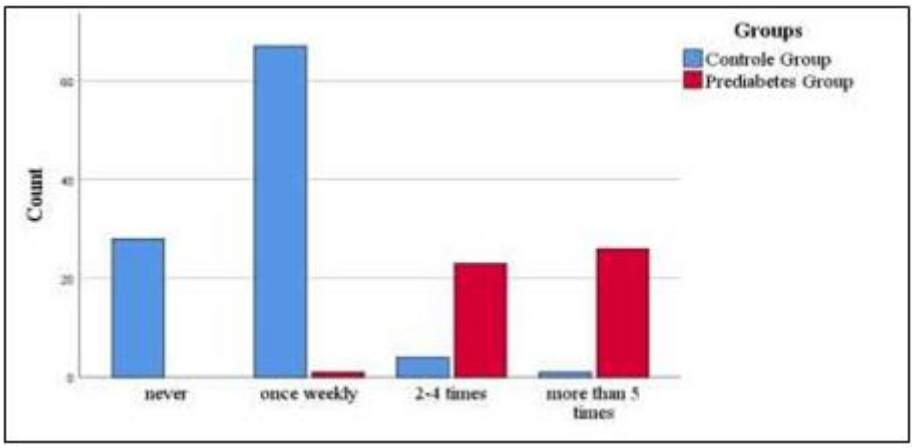

Figure 4: Consumption of sugar drinks and sweets among the study sample.

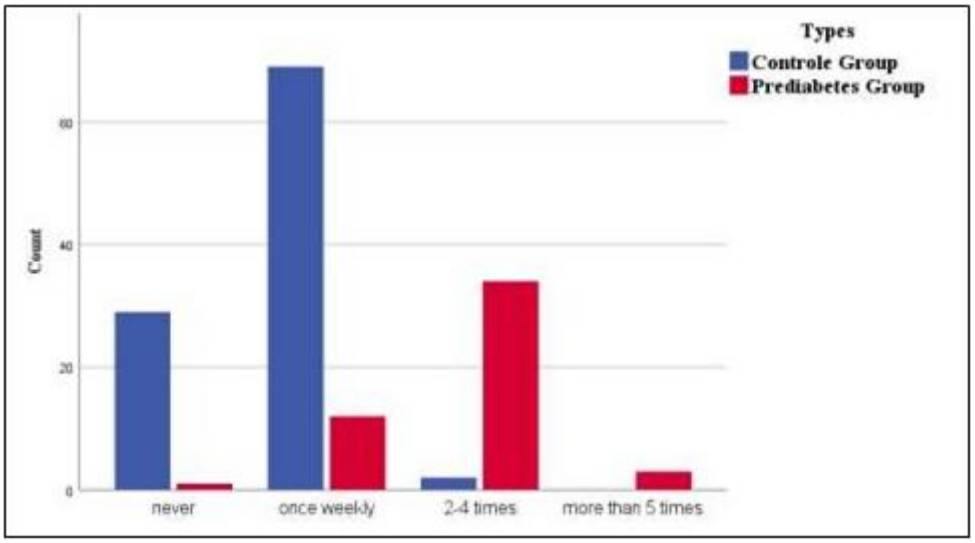

Figure 5: Consumption of fast food and high in fat and oil among the study sample.

Table 6: Physical activity among the study sample

Physical activity:	Cases = 50		Control = 100		Total= 150		P Value*	Odd ratio	C.I. 95%
	No.	%	No.	%	No.	%			
Days per week a child engages in active sport.									
Never	35	70.0	14	14.0	49	32.6	0.001	14.33	6.265: 32.79
1- <3	14	28.0	80	80.0	94	62.7	0.001	0.097	0.044: 0.214
3- <5	0	0.0	6	6.0	6	4.0	0.179**		
≥ 5	1	2.0	0	0.0	1	0.7	0.333**		
Hours per day children spend on phone, TV, and video games									
Never	2	4.0	15	15.0	17	11.3	0.045	0.236	0.052: 1.077
1- <3	3	6.0	59	59.0	62	41.3	0.001	0.044	0.013: 0.152
3- <5	22	44.0	26	26.0	48	32.0	0.026	2.236	1.094: 4.572
≥ 5	23	46.0	0	0.0	23	15.3	0.001		
***Using X^2 test **using fisher exact test**									

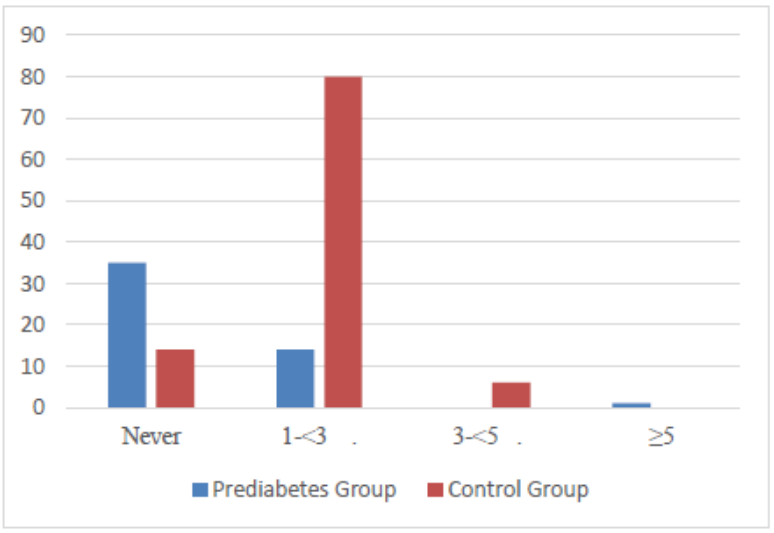

Figure 6: Children engage in active sport in days per week among the study sample.

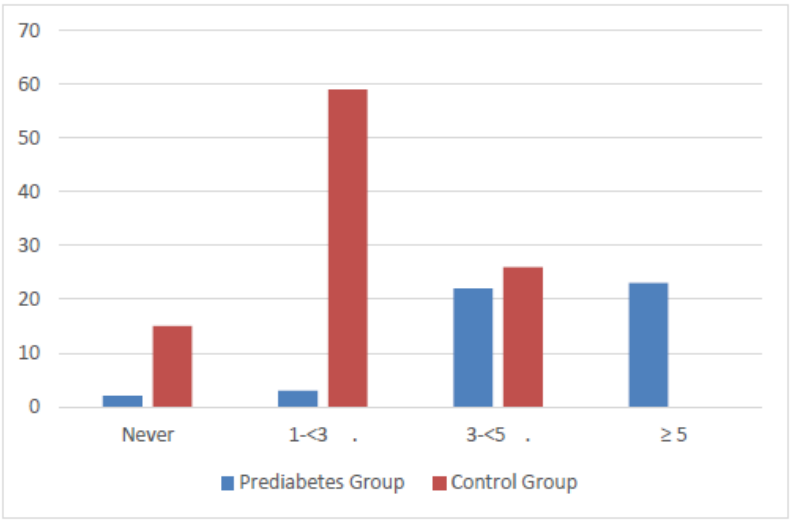

Figure 7: Children's spending on TV, video games, and phone in hours per day among the study sample.

5. DISCUSSION

Premarital screening (PMS) is an important preventive strategy, particularly in regions with high rates of consanguineous marriage, such as Mosul. This study revealed poor knowledge of PMS among participants, despite generally positive attitudes and good practices. Higher knowledge levels were associated with a greater likelihood of avoiding at-risk marriages.

5.1 Sociodemographic Characteristics

This study demonstrated that parental educational level, particularly paternal education, was significantly associated with childhood prediabetes, whereas children's age, sex, and maternal employment were not. Higher parental education may enhance health literacy, promote healthier dietary behaviors, and improve access to preventive healthcare. In addition, overweight and obesity were strongly associated with prediabetes, consistent with previous studies reporting excess adiposity as a major determinant of insulin resistance and impaired glucose metabolism in children.

5.2 Family History and Medical Factors

A family history of diabetes and obesity, particularly among fathers, mothers, and grandparents, was significantly associated with prediabetes, supporting the combined influence of genetic susceptibility and shared family lifestyle. Obesity, hypercholesterolemia, and chronic endocrine disorders were also significant predictors of prediabetes, consistent with evidence that metabolic abnormalities frequently cluster during the early stages of glucose dysregulation. These findings emphasize the importance of family-based screening and early metabolic assessment for high-risk children.

5.3 Dietary Habits

Unhealthy dietary behaviors, especially frequent consumption of sugar-sweetened beverages, sweets, and fast food, were strongly associated with prediabetes, whereas regular vegetable consumption showed a protective effect. These findings are consistent with previous research indicating that energy-dense diets promote obesity, insulin resistance, and impaired glucose regulation. Encouraging healthier dietary patterns during

childhood may therefore play an important role in preventing prediabetes.

5.4 Physical Activity

Children with prediabetes were less likely to participate in regular physical activity and more likely to spend prolonged periods on phones, watching television, and playing video games. These findings support previous evidence demonstrating that physical inactivity and excessive screen time contribute to obesity, reduced insulin sensitivity, and metabolic dysfunction. Promoting regular physical activity while reducing sedentary behaviors should therefore be considered a key component of childhood diabetes prevention programs.

5.5 Public Health Implications

Overall, the findings indicate that childhood prediabetes is driven by multiple interacting sociodemographic, familial, medical, dietary, and lifestyle factors. Because many of these determinants are modifiable, early screening of high-risk children, family-centered health education, promotion of healthy nutrition, increased physical activity, and weight management programs should be prioritized. Given the limited epidemiological evidence from Iraq, these findings provide valuable local data to support the development of targeted prevention strategies and public health policies aimed at reducing the future burden of type 2 diabetes among children.

6. Conclusion and Recommendations

This study identified obesity, a family history of diabetes and obesity, unhealthy dietary habits, physical inactivity, and prolonged screen time as the major risk factors associated with prediabetes among children aged 5–14 years in Nineveh Governorate. These findings highlight the multifactorial nature of childhood prediabetes and emphasize the importance of early identification of high-risk children, particularly those with obesity or a positive family history. Preventive strategies should focus on promoting healthy dietary habits, increasing regular physical activity, reducing recreational screen time, and implementing targeted screening programs for high-risk children to prevent progression to type 2 diabetes mellitus. Further large-scale, longitudinal studies are recommended to validate these findings and provide stronger evidence for developing effective prevention and management strategies in Iraqi children.

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