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THE NUTRITIONAL STATUS OF INSULIN DEPENDENT DIABETES MELLITUS-AFFECTED CHILDREN AND ADOLESCENTS IN MOSUL CITY: A CASE-CONTROL STUDY

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ABSTRACT

Background: Insulin dependent diabetes is mostly controlled by diet, and a poor diet can impact metabolic balance and have other detrimental health implications. Since children with insulin dependent diabetes are in growing state malnutrition can cause a major problem due to the incapacitating and chronic nature of the condition as a result, their nutritional status should be routinely assessed. **Objectives:** To assess the nutritional status of children and adolescents who have insulin-dependent diabetes mellitus and identify potential risk factors for undernutrition in Mosul City. **Methods:** It is a descriptive, observational, case-control study. The study was carried out in Mosul's Al Khansa'a and Ibin Sina Teaching Hospitals between the beginning of October 2022 and the end of September 2023. One hundred randomly chosen patients with insulin-dependent diabetes mellitus under the age of fifteen and had the disease for at least a year (cases) were included in the study. They were compared with one hundred controls who were matched for age and gender. The questionnaire consists of three sections: the first asks questions about socio-demographics, the second asks questions about anthropometry, and the third asks questions about diabetes. **Results:** Out of 200 participants included in the study; 110 (55%) were females and 90 (45%) were males. With female: male ratio= 1.22. The study participants had a mean age of 10.23 ± 3.78 years. There were significant differences between patients and controls in terms of weight for age Z score, height for age Z score, BMI for age Z score, and mid upper arm circumference Z score (P value < 0.001). Moreover; the case group is divided into two subgroups, patients with normal nutritional state represent 75 cases and those with undernourished presenting 25 cases, statistically significant difference is found between these sub-groups regarding their ages (P value=0.041) and their onset of diabetes (P value 0.021). Weight for age Z-score and BMI Z-score were founded to have mild negative correlation with HbA1c level (P value=0.015 and 0.029), respectively. Furthermore; multivariate logistic regression revealed that school age (OD=0.67, CI=0.356-0.971, P value=0.041), Adolescent (OD=3.48, CI=1.389-5.381, P value=0.035), female gender (OD=2.36, CI=1.023-3.202, P value=0.033), large family size (OD=2.892, CI=2.135-3.355, P value=0.028), disease duration (OD=1.823, CI=1.092-2.490, P value=0.024) were independent predictors of undernutrition in insulin dependent diabetes mellitus. **Conclusion:** Anthropometric measurements were significantly lower in patients with insulin-dependent diabetes mellitus than in the general population. In insulin dependent diabetes mellitus, undernutrition was found to be independently associated with length of disease, female gender, larger family size, and older children. Additionally, there was a significant negative association between BMI, weight for age, and HbA1c.

KEYWORDS: Nutrition, Type 1, Diabetes, Mosul, Iraq.

1. INTRODUCTION

Diabetes mellitus is a dangerous non-communicable disease that can last a lifetime and has been linked to both obesity and chronic undernutrition.[1] One of the previously recognized causes of significant growth retardation was diabetes.[2] The glycemic control of children with diabetes and health services have been impacted by the wars and conflicts that have damaged Iraq's healthcare system.[3] Insulin dependent diabetes is mostly controlled by diet, and a poor diet can impact metabolic balance and have other detrimental health implications.[4-5] Since children with insulin dependent diabetes are in growing state malnutrition can cause a major problem due to the incapacitating and chronic nature of the condition as a result, their nutritional status should be routinely assessed.[6]

Gender, genes, age at onset, growth hormone levels, length of disease, metabolic management, and puberty are some of the factors that affect growth in DM patients.[7-10] Undernutrition in children is defined as a mismatch between nutritional intake and demand, which results in cumulative deficiencies in energy, protein, and micronutrients that may impair normal development and growth.[11] Nutritional assessment is a challenging problem among children with insulin dependent diabetes, and should be taken into account when these patients have routine follow-up appointments.[12] Anthropometric measures of body weight, height, and length are required for the evaluation of undernutrition demands. These variables are then plotted on population growth charts for comparison with normal values.[13]

Anyhow, the consistency of anthropometric measures for diabetes mellitus follow-up are still up for dispute.[14] Thus, in addition to other clinical characteristics, a combination of data such as body weight, height, mass index, Mid upper arm circumference (MUAC), and Triceps skinfold thickness (TSFT) should be taken into account for nutritional evaluation in children with diabetes mellitus.[15-16]

This study aimed to assess the nutritional status of children and adolescents who have insulin-dependent diabetes mellitus and identify potential risk factors for undernutrition in Mosul City.

PATIENT AND METHODS

At the Al Wafaa Specialized Center for Endocrine Diseases and Al Khansa'a Teaching Hospital in Mosul, Iraq, a case-control study was carried out over a one-year period, from the start of October 2022 to the end of September 2023. One hundred randomly chosen patients with insulin dependent diabetes mellitus under the age of fifteen and they had the disease for at least a year were included in the study. They were compared with 100 healthy controls with matched ages and genders. Patients with celiac disease, hypothyroidism, inflammatory bowel diseases, type 2 diabetes, and any other medical conditions were not included in the study.

The questionnaire asked about the patient's age, gender, family size (more than three children deemed large), and family income (categorized as low if the family income less than one hundred thousand Iraqi dinars per capita), medium (between one hundred thousand Iraqi dinars per capita), and high more than two hundred thousand Iraqi dinars per capita).[15], age at which diabetes first appeared, how long the condition has been present since diagnosis, how many diabetic ketoacidosis occurred during the course of the illness, and the results of the HbA1c test (performed within the last three months). The HbA1c levels were assessed using a direct enzymatic assay and categorized as good glycemic control when it is less than 7.5%, intermediate when it is between 7.5% and 9.0% and poor if it is more than 9.0%.[17]

Anthropometric measures including height, weight, body mass index (BMI), mid-upper arm circumference (MUAC) and triceps skin fold thickness (TSFT), were measured as part of a comprehensive and systematic evaluation of every patient. Participants were measured for height and weight while not wearing shoes and in light clothing. A manual scale was used to measure the participant's weight. The researcher made sure the participant's back was straight while they stood on the scale with their arms outstretched along their sides. A wall stadiometer with a precision scale of 0.1 cm was used to measure height while they were standing barefoot and facing the wall. By dividing weight in kilos by height in meters squared, the body mass index (BMI) was determined. The National Health and Nutrition Examination Survey's guidelines were followed while measuring the circumference of the mid-upper arm with a Gulick tape (Baseline 12-1201) at a precision of 0.5 cm. With an accuracy of 0.1 mm, the Saehan Medical Skinfold Caliper (SH5020) was also used to measure the thickness of the triceps skin fold. Measurements were taken on the non-dominant side of the body at a quarter of the distance between the iliac and navel in an oblique hold, immediately below the shoulder blades in a horizontal grip, and directly above the upper arm vertical grip's triceps muscle. Each location's test was conducted three times, and the average of the results was then determined. By converting the growth parameters into Z scores, they were adjusted for age. Z scores were used instead of the more conventional placing "near" or "below" a particular percentile curve because they allow for greater accuracy in conveying anthropometric status. Measurements that fall more than two standard deviations (SD) below the mean are indicative of malnutrition, whereas normal values are within two SD from the mean.

Scientific package for social sciences (SPSS) software version 30.0 was used to carry out the statistical analysis. After determining if the data was normally distributed using the Shapiro-Wilk test, the dispersed data was displayed using mean ± SD. Using a Student's t-test, the data was compared. The Mann-Whitney U test was employed for analysis, and the median and range were utilized to describe data with non-normal distributions. To assess categorical data, which were represented as percentages and numbers, the Chi-square/Fischer exact test was used. Using Pearson's correlation, the relationship between age and disease duration and other national indices was examined. Multivariate logistic regression was used to find independent undernutrition predictors based on BMI in people with insulin-dependent diabetes. A p-value considered statistically significant if it was less than 0.05.

RESULTS

The study includes 200 patients, of them; 100 patients with insulin dependent diabetes mellitus (cases) which were compared to 100 age and gender-matched healthy controls. Moreover; 110 (55%) were females and 90

(45%) were males. With female: male ratio= 1.22. The mean age of the study participants was 10.23 ± 3.78 years.

Table 3.1 shows comparison between cases and controls regarding anthropometric measurements. Its evident that statistically significant differences were found between patients with diabetes (cases) and controls regarding weight for age Z score, Height for age Z score, BMI for age Z score, Mid upper arm circumference Z score (P value <0.001) for all. From the other hand no statically significant differences between cases and controls regarding triceps skinfold thickness Z score (P value =0.198).

Table 3.1: Anthropometric measurements of the study participants.

Variable	Cases = 100	Controls = 100	P value
Weight for age Z score: - Mean ± Standard deviation - Median ± Interquartile range	 -0.25±0.14 -0.35 (-2.66-2.41)	 0.57±1.31 0.52 (-1.89-2.5)	**<0.001**
Height for age Z score: - Mean ± Standard deviation - Median ± Interquartile range	 -0.71±1.33 -0.82 (-3.19-2.21)	 0.25±1.13 0.31 (-3.0-3.2)	**<0.001**
BMI for age Z score: - Mean ± Standard deviation- - Median ± Interquartile range	 0.17±0.89 0.13 (-2.05-2.22)	 2.09±0.91 2.16 (-0.25-3.61)	**<0.001**
Mid upper arm circumference Z score: - Mean ± Standard deviation - Median ± Interquartile range	 -1.47±1.26 -1.0 (-3.94-1.57)	 1.71±2.14 1.2 (-1.87-4.78)	**<0.001**
Triceps skinfold thickness Z score: - Mean ± Standard deviation - Median ± Interquartile range	 0.57±0.78 0.55 (-2.31-2.39)	 0.61±0.99 0.65 (-2.21-2.65)	 0.198

Table 3.2 illustrates the association of socio-demographic data and clinical characteristics of patients according to BMI z score, among patient with diabetes (cases) group. The cases group is divided into two subgroups, patients with normal nutritional state represent 75 cases and those with undernourished presenting 25 cases. Preschool (less than 6 years) age group represented by 12 (12%) patients, school age (6-12 years) represented by 62 (62%) patients, while adolescent (more than 12 years) represented by 26 (26%) patients, statistically significant difference is found between these sub-groups regarding their ages (P value=0.041). Moreover; females were predominant over males (55%) with no statistically significant differences (P value =0.221). Furthermore; more than half of diabetic patients (55%) were from medium income state, versus 29% were from low income state and 16% were from high income state, the differences between the two subgroups was statistically significant regarding income state (P=0.168). From the other hand; 73% of the diabetic patients were belong to large family size versus 27% were belong to small family size the difference between the two subgroups was statistically not significant regarding this point (P value=0.837). Patients with undernourished are found older age at onset of diabetes than normal nutritional state with statistically significant difference (P value 0.021). Additionally; 75% of patients had diabetes for less than 5 years with no statistically significant difference between the two subgroups regarding income state (P=0.239). Another 75% of patients had 0-2 attacks of diabetic ketoacidosis (DKA), 18% reported 3-5 DKA attacks and 7% reported 6-8 DKA attacks, with no statistically significant difference between the two subgroups regarding DKA attacks (P value=0.635). Lastly; more than half of the patients (53%) having HbA1C more than 9%, versus quarter of them having HbA1c from 7.5-9% and only 22% having HbA1c less than 7.5, with no statistically significant difference between the two subgroups regarding HbA1c percent (P value=0.826).

Table 3.2: The association of socio-demographic data and clinical characteristics of patients according to BMI z score, among patient with diabetes (cases) group.

Variable	Normal = 75	Undernourished = 25	P value
Age (years): - Less than 6 years - 6-12 years - More than 12 years	 9 (12%) 53 (70.7%) 13 (17.3%)	 3 (12%) 9 (36%) 13 (52%)	 **0.041**
Gender: - Male - Female	 33 (44%) 42 (56%)	 12 (48%) 13 (52%)	 0.221
Income: - Low - Medium	 20 (26.7%) 41 (54.7%)	 9 (36%) 14 (56%)	 0.168

- High	14 (18.6%)	2 (8%)	
Family size: - Small - Large	 21 (28%) 54 (72%)	 6 (24%) 19 (76%)	0.837
Age at onset of diabetes (years): Mean ± Standard deviation	 5.93 ± 2.83	 9.24 ± 2.93	**0.021**
Disease duration (years): - Less than 5 - More than 5	 55 (73.3%) 20 (26.7%)	 20 (80%) 5 (20%)	0.239
Diabetic ketoacidosis, number: - 0-2 - 3-5 - 6-8	 54 (72%) 15 (20%) 6 (8%)	 21 (84%) 3 (12%) 1 (4%)	0.635
HbA1c, Percent: - < 7.5 - 7.5-9 - > 9	 16 (21.3%) 19 (25.3%) 40 (53.4%)	 6 (24%) 6 (24%) 13 (52%)	0.826

Table 3.3 explores the correlation of insulin dependent diabetes mellitus duration and HbA1c with growth parameters. Weight for age Z-score and BMI Z-score were founded to have mild negative correlation with HbA1c level (P value=0.015 and 0.029), respectively. No correlation between growth parameters and disease duration (P value more than 0.05 for all). Moreover; no correlation was found between height for age Z-score, triceps skin fold thickness Z score and mid upper arm circumference Z-score and HbA1c level.

Table 3.3: The correlation of insulin dependent DM duration and HbA1c with growth parameters.

Variable	Disease duration		HbA1c	
	Correlation	P value	Correlation	P value
Weight for age Z-score	0.245	0.467	-0.329	**0.015**
Height for age Z-score	-0.198	0.348	-0.248	0.149
Body mass index Z-score	0.112	0.145	-0.298	**0.029**
Triceps skin fold thickness Z-score	-0.384	0.398	0.138	0.289
Mid upper arm circumference Z-score	-0.339	0.136	0.267	0.398

Table 3.4 shows a multivariate logistic regression test which was performed to determine the independent predictors in insulin dependent diabetes mellitus patients according to their BMI. The study revealed school age (OD=0.67, CI=0.356-0.971, P value=0.041), Adolescent (OD=3.48, CI=1.389-5.381, P value=0.035), female gender (OD=2.36, CI=1.023-3.202, P value=0.033), large family size (OD=2.892, CI=2.135-3.355, P value=0.028), disease duration (OD=1.823, CI=1.092-2.490, P value=0.024) were independent predictors of undernutrition in insulin dependent diabetes mellitus. From the other hand; income state, diabetic ketoacidosis, HbA1c percent were shown no significant predication results.

Table 3.4: Predictors of undernutrition in type1 DM patients according to BMI.

Variable	Odds ratio	Confidence Interval	P value
Age (years): - Less than 6 years - 6-12 years - More than 12 years	 1.0 0.67 3.48	 **0.356-0.971** **1.389-5.381**	 **0.041** **0.035**
Gender: - Male - Female	 1.0 2.36	 **1.023-3.202**	 **0.033**
Income: - Low - Medium - High	 1.239 1.0 0.234	 0.237-1.982 0.029-1.002	 0.292 0.484 0.562
Family size: - Small - Large	 1.0 2.892	 **2.135-3.355**	 **0.028**
Disease duration (years): - Less than 5	 1.0		

- More than 5	1.823	**1.092-2.490**	**0.024**
Diabetic ketoacidosis, number:			
- 0-2	1.0		0.178
- 3-5	0.723	0.382-1.302	0.282
- 6-8	0.638	0.192-1.281	0.374
HbA1c, Percent:			
- < 7.5	1.0		0.328
- 7.5-9	1.202	0.299-1.829	0.492
- > 9	1.290	0.389-1.639	0.237

4. DISCUSSION

Few studies have evaluated the dietary condition of children and adolescents with insulin dependent diabetes. The current study highlights the need of regularly checking anthropometric measurements and examining these patients' nutritional state. This gives healthcare providers a safe, non-invasive way to monitor metabolic control and guarantee insulin-dependent diabetes patients have normal somatic development for their age.

The anthropometric measurement of the study explored significant differences between the cases and controls regarding; weight for age Z score, height for age Z score, BMI for age Z score and MUAC for age Z score but not TSFT for age Z score. Which is parallel to Sawsan Ali Hussein et al[15] and Khadilkar et al[18] study findings. This is means that diabetes can cause negative impact to the nutritional state of the affected child.

Regarding the patients' age, the current study shows that adolescents and those with diabetes onset at the age of around ten are liable for nutritional problem, given that proper growth and development depend on nutrition, this finding could be explained by the possibility that older age groups have nutritional restrictions whereas younger age groups do not. Additionally, sex hormones may counteract the effects of insulin in teenagers, potentially disrupting their metabolic regulation, comparable results were obtained from Ban Rahman Dohan et al.[19]

Concerning the correlation of HbA1c with growth parameters. The study founded that weight for age Z-score and BMI Z-score had significant negative correlation with HbA1c level, this finding is going with Hala M. Sakhr et al study results.[20]

The current study found that school age, adolescent age, female gender, a large family size, and longer disease duration are all independent risk factors for undernutrition in insulin dependent diabetes. Sawsan Ali Hussein et al. support these findings.[15] However, systematic review of other studies be crucial in gaining a deeper insight into the growth status of children with insulin dependent diabetes.

When interpreting the findings, it is important to take into account the limitations of the current study. First, the results may not be as easily applicable to different populations due to the small sample size. Second, the study was only carried out at one center, which can have limited the findings' external validity. Moreover, the absence of additional HbA1c tests may have resulted in measurement mistakes and decreased the precision of the study findings.

4. CONCLUSIONS AND RECOMMENDATIONS

Anthropometric measurements were significantly lower in patients with insulin-dependent diabetes mellitus than in the general population. In insulin dependent diabetes mellitus, undernutrition was found to be independently associated with length of disease, female gender, larger family size, and older children. Additionally, there was a significant negative association between BMI, weight for age, and HbA1c. More multi-centric studies with bigger sample numbers are needed in the future to confirm the study's findings.

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Conflict of intertest

About this study, the authors disclose no conflicts of interest.

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