Risk Factors of Uncontrolled Hyperglycemia in Children and Adolescents with Type 1 Diabetes Mellitus

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Abstract

Background: In Iraqi children with type 1 diabetes mellitus, glycemic control levels and risk factors for uncontrolled hyperglycemia are unknown. The aim of the study to assess the factors that increase the risk of uncontrolled hyperglycemia in children and adolescents with type 1 diabetes mellitus, and identify levels of glycemic control in children and adolescents with type 1 diabetes mellitus.

Methods: A cross-sectional study was carried out from September 21 2020 until the end of May 2021 to identify levels of glycemic control and assess the risk factors of uncontrolled hyperglycemia in children and adolescents with type 1 diabetes mellitus, for the study sample which was 209 type 1 diabetics, selected randomly from the visitors of a Faiha Specialized Diabetes, Endocrine, and Metabolism Center (FDEMC). The American Diabetes Association assigned target HbA1c levels to patients based on their age groups. Comparison has been made of well-controlled patients and uncontrolled hyperglycemia patients. To assess each risk factor's role in uncontrolled type 1 diabetes hyperglycemia, the Odds Ratios were calculated.

Results: Only 17.2% of children and adolescents with type 1 diabetes mellitus were well-controlled diabetes. Better glycemic control was related to age < 6 years, BMI, and duration of type 1 diabetes <5 years. Glycemic control was not affected by gender, residence, socio-economic status.

Conclusion: Type 1 diabetes mellitus glycemic control among children and adolescents in Al-Basra/ southern Iraq varies widely, risking microvascular complications. In well-control type 1 diabetes mellitus patients, females were higher than males and in the age group (1-6) years, higher than the other age groups. While in uncontrolled patients with type 1 diabetes, about (57.2%) had an episode of diabetic ketoacidosis (DKA). The major risk factors for uncontrolled hyperglycemia are excessive sweet intake, fast food, and irregular meals.

Keywords: *Risk factors, Children, Adolescents, Hyperglycemia, Ketoacedosis (KDA)*

Introduction

Diabetes mellitus is a huge and growing global health problem that demands modern therapy involving greater and earlier use of intensive insulin regimens to achieve better control of blood glucose levels and reduce the long-term risks associated with the condition [(1)]. Well-controlled patients with type 1 diabetes mellitus pediatric are not only important

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to decrease complications and delay progression, but also to normal growth and development [2]. However, in most clinical settings, glycemic control is inadequate. According to one study, Just 37% of diabetes mellitus adults have achieved a 7% HbA1c level [3]. Further, in one pediatric study, the mean level of HbA1c was found to be 8.8% [4], indicating that the majority of children did not meet the recommended target level of HbA1c less than 7.5% [5]. Uncontrolled hyperglycemia may be caused by failure to take medication on time, eat too much and exercise too little. Some episodes of hyperglycemia occur for no apparent cause. Illness may also cause a rise in blood glucose levels. Hyperglycemia can damage the kidneys, nerves, blood vessels, eyes, teeth, and gums over time. Hyperglycemia-related neurocognitive complications have also been reported [6]. During a nationwide Iraq project conducted between 1 January 2012 and 31 December 2016, 818 new cases of type 1 diabetes were found, coinciding with a worldwide rise in the incidence of diabetes. Males made up 417 of these (50%). The annual incidence rate of type 1 diabetes was 7.4 per 100,000, and the prevalence rate of type 1 diabetes in people aged less than 40 was 87 per 100,000 in 2016 [7]. However, few studies in Iraqi children and adolescents with glycemic control scale type 1 diabetes as well as risk factors associated with uncontrolled hyperglycemia have been carried out in Iraq.

Methods

A cross-sectional study was carried out from September 21 2020 until the end of April 2021 to identify levels of glycemic control and assess the risk factors of uncontrolled hyperglycemia in children and adolescents with type 1 diabetes mellitus, for the study sample which was 209 type 1 diabetics, selected randomly from the visitors of a Faiha Specialized Diabetes, Endocrine, and Metabolism Center (FDEMC). The American Diabetes Association assigned target HbA1c levels to patients based on their age groups. Comparison has been made of well-controlled patients and uncontrolled hyperglycemia patients. To assess each risk factor's role in uncontrolled type 1 diabetes hyperglycemia, the Odds Ratios, was calculated. At the time of the study, we followed the American Diabetes Association (ADA) 2014 Guidelines. The data of all patients were obtained from interview patients and the digital records of (FDEMC) as it has an internal network system and Microsoft Access program for documenting all patients' information and investigations. Statistical analysis: Together, study data are shown as {means, median, and ± standard deviation (SD)} or percentages (%). The variations between the groups of the study were established by the Chi-square test, Mann Whitney test, and the Kruskal Wallis test. Statistical significance is designated by a value of $P. < 0.05$. All statistical investigates were attained by utilizing IBM SPSS (version 25).

Results

Table (1) The basic socio-demographic characteristics of the study sample:

Parameters		Glycemic Control No. = 209		P. Value
		Uncontrolled HG (n = 173)	Well Control (n = 36)	
HbA1c%	N (%)	173 (82.78%)	36 (17.22%)	<0.001
	Mean ± SD	11.39 ± 2.25	7.21 ± 0.48	
	Median	10.90	7.00	
	Range	12.5 (7.8-20.3)	1.5 (6.5-8)	
Age (Mean ± SD (median)) in years		12.45 ± 4.05 (13.0)	10.53 ± 4.20 (10.5)	0.016
Sex	Male	91 (52.6%)	17 (47.2%)	0.557
	Female	82 (47.4%)	19 (52.8%)	
BMI In kg/m2	Very underweight	2 (1.2%)	1 (2.8%)	0.009
	Underweight	11 (6.4%)	0 (0.0%)	
	Normal weight	114 (65.9%)	17 (47.2%)	
	Overweight	34 (19.6%)	15 (41.7%)	
	Obese	12 (6.9%)	3 (8.3%)	
	(Mean ± SD (Median)	19.13 ± 4.15 (18.48)	19.34 ± 4.71 (18.89)	
Residence	Urban	101 (58.4%)	18 (50.0%)	0.355
	Rural	72 (41.6%)	18 (50.0%)	
Socioeconomic status	Low	72 (41.6%)	12 (33.3%)	0.243
	Intermediate	92 (53.2%)	19 (52.8%)	
	High	9 (5.2%)	5 (13.9%)	
Age at diagnosis	<= 5 years	36 (20.8%)	12 (33.3%)	0.260
	6 – 10 years	82 (47.4%)	15 (41.7%)	
	>10 years	55 (31.8%)	9 (25.0%)	
	Mean ± SD	8.20 ± 3.864	7.31 ± 4.077	
Duration of T1DM	<= 5 years	111 (64.2%)	31 (86.1%)	0.031
	6 – 10 years	48 (27.7%)	3 (8.3%)	
	>10 years	14 (8.1%)	2 (5.6%)	
	Mean ± SD	4.26 ± 3.407	3.22 ± 3.072	

Table (2) Age grouping distribution according to Glycemic Control:

Age Group	Glycemic Control No. = 209		P. Value
	Uncontrolled HG n (%)	Well Control n (%)	
Total	173 (82.8%)	36 (17.2%)	0.043
1 – 6	17 (65.4%)	9 (34.6%)	
7 – 12	68 (85.0%)	12 (15.0%)	
13 – 18	88 (85.4%)	15 (14.6%)	
Mean ±SD	12.40 ± 4.05	10.53 ± 4.22	

Table (3) Distribution Risk Factors according to Glycemic Control of the sample:

Parameter		Glycemic Control No. = 209		OR (95% CI)	P. Value
		Uncontrolled (HG) n (%)	Well Control (n = 36)		
Large amount of food intake	Yes	117 (67.6%)	16 (44.4%)	2.61 (1.26-5.42)	0.009
	No	56 (32.4%)	20 (55.6%)	-	
Excessive fast foods (Unhealthy foods)	Yes	123 (71.1%)	15 (41.7%)	3.44 (1.64-7.22)	0.001
	No	50 (28.9%)	21 (58.3%)	-	
Excessive intake of sweets	Yes	110 (63.6%)	10 (27.8%)	4.54 (2.06-10.03)	<0.001
	No	63 (36.4%)	26 (72.2%)	-	
Lack of regular times for meals	Yes	164 (94.8%)	26 (72.2%)	7.01 (2.60-18.88)	<0.001
	No	9 (5.2%)	10 (27.8%)	-	
Lack of Patient compliance with healthy lifestyle	Yes	162 (93.6%)	20 (55.6%)	11.78 (4.80-28.9)	<0.001
	No	11 (6.4%)	16 (44.4%)	-	
Independent management without parental supervision	Yes	68 (39.3%)	4 (11.1%)	5.18 (1.75-15.31)	0.001
	No	105 (60.7%)	32 (88.9%)	-	
Diabetes ketoacidosis (DKA)	Yes	74 (42.8%)	1 (2.8%)	26.16(3.5-195.3)	<0.001
	No	99 (57.2%)	35 (97.2%)	-	
Have been hospitalized for your diabetes?	Yes	105 (60.7%)	15 (41.7%)	2.16(1.04-4.48)	0.036
	No	68 (39.3%)	21 (58.3%)	-	
Recurrent stress and/or infections	Yes	165 (95.4%)	28 (77.8%)	5.89(2.04-16.99)	<0.001
	No	8 (4.6%)	8 (22.2%)	-	
Frequent unexplained hypoglycemia	Yes	46 (26.6%)	1 (2.8%)	12.7(1.69-95.20)	0.002
	No	127 (73.4%)	35 (97.2%)	-	
Do you exercise regularly?	Yes	13 (7.5%)	2 (5.6%)	1.38(0.3-6.4)	0.679
	No	160 (92.5%)	34 (94.4%)	-	

Discussion

A total of 209 types 1 diabetic, 36 (17.22%) with well-controlled diabetes, and 173 (82.78%) with uncontrolled hyperglycemia diabetes were already diagnosed as T1DM patients and involved in this study between the ages of (2–18) years. The results show that the patients with well-controlled diabetes in T1DM (median HbA1c = 7.00%) are significantly less than those with uncontrolled hyperglycemia diabetes T1DM (median HbA1c = 10.90%) with a statistically significant difference, was found (P < 0.001). This finding indicates that the percentage of glycemic control of diabetes in uncontrolled hyperglycemia diabetes was higher (about four times higher) than in well-controlled diabetes, which is consistent with other research like this [8] and with a statistically significant difference, was found (P < 0.001). The results show that the patients with uncontrolled hyperglycemia diabetes T1DM (median age = 13 years) are significantly greater than those with well-controlled diabetes in T1DM (median age =10.5 years) with a significant statistical difference between the two diabetic groups (P = 0.016). This study records that in uncontrolled hyperglycemia diabetes patients there were (52.6%) males, while in well-controlled diabetes patients there were (52.8%) females. This result shows that well-controlled diabetes in females was higher than in males, which is in agreement with other studies like these by [1,8–11], with no statistically significant difference, was found (P = 0.557). For body mass index, the median with uncontrolled hyperglycemia diabetes T1DM patients (18.48 kg/m2) was significantly less than that in well-controlled diabetes in T1DM patients (18.89 kg/m2), (P. = 0.009), may be associated with uncontrolled hyperglycemia diabetes and corresponds with the studies by [12,13]. The present study found that among the sampled population with uncontrolled hyperglycemia diabetes T1DM patients, 101 (58.4%) were from urban, 72 (41.6%) were from rural, whereas in well-control diabetes with T1DM patients 18 (50.0%) were from urban, and 18 (50.0%) were from rural, and without a statistically significant difference, was found (P = 0.355), and corresponds with the study by [14]. According to Socioeconomic status in uncontrolled hyperglycemia type 1 diabetes patients, 92 (53.2%) were in an intermediate socioeconomic status, 9 (5.2%) a high socioeconomic status, while in well-control type 1 diabetes, 19 (52.8%) were in an intermediate socioeconomic status, 5 (13.9%) in a high socioeconomic status, and with no, a statistically significant difference, was found (P. = 0.243), and corresponds with the study by (14). This shows that with type 1 diabetes in uncontrolled hyperglycemia patients according to the age at diagnosis, (47.4%) were diagnosed at the age (6 – 10) years old, when the mean of age for all subjects is 8.20 ± 3.864 years old, while in well-controlled with type 1diabetes patients according to the age at diagnosis, (41.7%) were diagnosed at the age (6 – 10) years old, when the mean of age for all subjects is 7.31 ± 4.077 years old. In our group of patients, the age at which they were diagnosed with diabetes did not affect the disease's metabolic control or without a statistically significant difference, was found (P. = 0.260) which is in agreement with this study [15–17]. The duration of type 1 diabetes <= 5 years, in uncontrolled hyperglycemia diabetes patients, was the highest (64.2%), when the mean of age for all subjects is 4.26 ± 3.407 years old, as well in well-controlled T1DM patients <= 5 years was the highest (86.1%) when the mean of age for all subjects is 3.22 ± 3.072 years old, with a statistically significant difference, was found (P. = 0.031) which is in agreement with this study [13].

The study discovered that among the sampled population, 88 (85.4%) of uncontrolled hyperglycemia diabetes T1DM patients were for the age group (13 – 18) years old, with a mean age of (12.40) years, whereas 9 (34.6%) of well-control diabetes with T1DM patients were for the age group (1 – 6) years

old, with a mean age of (10.53) years. This result shows that well-controlled diabetes with T1DM patients in the age group (1 – 6) years was higher than the rest age groups, patients in this group were more likely to be in the good glycemic control community, and with a statistically significant difference, was found (P. = 0.043), which is in an agreement with another study like this by [15].

According to the amount of food intake, the present study found in uncontrolled hyperglycemia diabetes patients, who had 2.61 times (95% CI = 1.26-5.42) higher than odds of good control diabetes patients, an indicator of high risk for uncontrolled hyperglycemia diabetes, with a statistically significant difference, was found (P = 0.009). In terms of excessive fast food consumption (Unhealthy foods), Compared with patients with an excessive fast foods intake, had 3.44 times (95% CI = 1.64-7.22) higher odds of uncontrolled hyperglycemia diabetes patients, and good control diabetes patients, an indicator of high risk for uncontrolled hyperglycemia diabetes, with a statistically significant difference, was found (P = 0.001) which is in agreement with this study [5]. Regarding the excessive sweets food intake, compared with patients with an excessive intake of sweets, had 4.54 times (95% CI = 2.06-10.03) higher odds of uncontrolled hyperglycemia diabetes patients, and good control diabetes patients, an indicator of high risk for uncontrolled hyperglycemia diabetes, with a statistically significant difference, was found (P. < 0.001). However, excess sweets intake, fast food consumption (Unhealthy foods), and a large amount of food intake have been linked to an increased risk of developing uncontrolled hyperglycemia type 1 diabetes with rather than well-controlled hyperglycemia type 1 diabetes. According to the regular times for meals, the present study found in uncontrolled hyperglycemia diabetes patients, compared with patients with a lack of regular times for meals, had 7.01 times (95% CI = 2.60-18.88) higher odds of uncontrolled hyperglycemia diabetes patients, and good control diabetes patients, an indicator of high risk for uncontrolled hyperglycemia diabetes, with a statistically significant difference, was found (P. < 0.001) which is in agreement with this study [5]. Regarding patient compliance with a healthy lifestyle, the present study found in uncontrolled hyperglycemia diabetes patients, compared with patient's compliance with a healthy lifestyle, had 11.78 times (95% CI = 4.80-28.9) higher odds of uncontrolled hyperglycemia diabetes patients, and well-control diabetes patients, an indicator of high risk for uncontrolled hyperglycemia diabetes, with a statistically significant difference, was found (P. < 0.001) which is in agreement with this study [18]. Excess sweets, unhealthy foods (mainly excessive intake of fast foods), and lack of consistent meal times were the most important factors associated with a significantly higher risk of uncontrolled hyperglycemia in the HG group relative to the good control group, as shown in **Table (3).** The present study found that diabetes ketoacidosis (DKA), in patients with type 1 diabetes with uncontrolled hyperglycemia, had 26.16 times (95% CI = 3.5-195.3) higher than the odds of well-control diabetes patients, an indicator of high risk for uncontrolled hyperglycemia diabetes, with a statistically significant difference, was found (P. <0.001), which is in agreement with this study [19]. However, in uncontrolled hyperglycemia diabetes patients, who were hospitalized diabetes through last week, had 2.16 times (95% CI = 1.04-4.48) higher than odds of well-control diabetes patients, an indicator of high risk for uncontrolled hyperglycemia diabetes, with a statistically significant difference between well-control diabetes and uncontrolled hyperglycemia diabetes was found (P. = 0.036) which is in agreement with this study [20]. According to recurrent stress and/or infections, in uncontrolled hyperglycemia diabetes patients, who had 5.89 times (95% CI = 2.04-16.99) higher than odds of well-control diabetes patients, an indicator of high risk for uncontrolled hyperglycemia

diabetes. with a statistically significant difference, was found (P. < 0.001) which is in confirm this study [20]. Regarding the frequent unexplained hypoglycemia, in uncontrolled hyperglycemia diabetes patients, had 12.7 times (95% CI = 1.69-95.20) higher than odds good control diabetes patients, an indicator of high risk for uncontrolled hyperglycemia diabetes, with a statistically significant difference, was found (P = 0.002) which is in agreement with this study [1,21]. According to regular exercise, in uncontrolled hyperglycemia diabetes patients, who had 1.38 times (95% CI = 0.3-6.4) higher than odds well-control diabetes patients, an indicator of high risk for uncontrolled hyperglycemia diabetes, with no statistically significant difference, was found (P. = 0.679) which is in agreement with this study [22]. For people with type 1 diabetes, daily exercise has many health benefits (e.g., improved cardiovascular fitness, muscle strength, insulin resistance, etc.)

Ethical Clearance: The Research Ethical Committee at scientific research by ethical approval of both MOH and MOHSER in Iraq

Conflict of Interest: None

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