

EVALUATION OF CARBOHYDRATE COUNTING AND GLYCEMIC CONTROL AMONG CHILDREN AND ADOLESCENTS WITH INSULIN DEPENDENT DIABETES IN MOSUL CITY

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ABSTRACT

Background: Insulin dependent diabetes mellitus is a chronic disease that is defined by the body's inability to produce enough insulin due to the autoimmune destruction of the pancreatic β cells. Nutritional therapy is still important factor for diabetic management, even with the advancements in medical science and technology. Children and Adolescents with type 1 diabetes should follow the same dietary guidelines for a healthy lifestyle as their peers without the disease; the only difference that separates them is the requirement for insulin therapy.

Objectives: Is to evaluate the effect of carbohydrate counting among children and adolescent with insulin dependent diabetes on their glycemic management. **Methods:** The study is an observational, descriptive, case series study. It was conducted between the 20th of September 2023 to the end of February 2025 at investigators private clinics in Mosul city. The questionnaire was composed from two tools. The first tool is adolescent's assessment sheet. The second Tool evaluates seven domains: four domains for carbohydrate detection and three domains for insulin dosage. **Results:** The study includes 120 child and adolescent with insulin dependent diabetes mellitus. The mean age \pm standard deviation of the study participants is 14.53 ± 0.83 years. Male: Female ratio was 0.739. It's evident that the age group of 10-14 years was the most prevalent age group among 66 (55%) patients. Moreover; 51 (42.5%) patients were males and 69 (57.5%) were females. Furthermore; 91 (75.83%) patients reported positive family history of diabetes mellitus. The mean duration of diabetes among the study participants was 6.129 ± 1.248 years. Almost half of the study patients had hyperglycemia at time of diagnosis and another approximately half reported hospitalization mostly due to diabetes ketoacidosis. Only 10% of the study participant consult dietitian. Mild negative and not significant correlation was founded between all of the glycemic control parameters (pre and post prandial blood glucose, random blood sugar and glycated hemoglobin) and total PCQ score. **Conclusion:** The findings of this study conclude that children and adolescents with insulin dependent diabetes had a low level of recognition with regard to the carbohydrate counting and that there was a negative but non-significant correlation between their total PCQ score and their glycemic control.

KEYWORDS: Carb counting, Insulin dependent, Children, Adolescent, Mosul, Iraq.

1. INTRODUCTION

Insulin dependent diabetes mellitus is a chronic disease that is defined by the body's inability to produce enough insulin due to the autoimmune destruction of the pancreatic β cells.^[1] Although the condition usually manifests in children, it may also affect people in their late 30s and early 40s.^[2] The combination of environmental and genetic variables causes insulin dependent diabetes mellitus, which changes the immune system and ultimately leads to the destruction of the pancreatic β cell.^[3-4]

The International Diabetes Federation, estimates that 8.8% of adults worldwide suffer from diabetes.^[5] Just 10% to 15% of them have insulin-dependent diabetes mellitus, which is more prevalent among children under the age of fifteen.^[6] The prevalence of insulin-dependent diabetes mellitus is approximately 1.1 million people worldwide, and it has been increasing by 3% yearly.^[7]

Nutritional therapy is still important factor for diabetic management, even with the advancements in medical science and technology.^[8] Children and Adolescents with type 1 diabetes should follow the same dietary guidelines

for a healthy lifestyle as their peers without the disease; the only difference that separates them is the requirement for insulin therapy.^[9]

Food has a big impact on blood sugar levels. Teenagers with insulin dependent diabetes should be aware of how food affects their blood sugar levels and adjust their meal plans accordingly.^[10] So that; referring the teenagers with insulin dependent diabetes to clinical dietitian who is qualified and experienced in offering dietary recommendations is mandatory for tailoring their condition.^[11] Among diet management strategies, carbohydrate counting which can give teenagers with insulin dependent diabetes more freedom in their meal choices and assist them in frequent pattern.^[12] The primary factor influencing post-meal blood glucose in people with insulin dependent diabetes is dietary control, particularly the monitoring of carbohydrate intake.^[13]

The main objective of diabetes treatment is to bring blood glucose levels (both postprandial and fasting) as close to normal as acceptable.^[13-14] The biggest impact on glycemic response is the total amount of carbohydrates consumed.^[15] The standard recommendation for the distribution of energy sources is 50-55% carbohydrates, 35% fats, and 10%-15% protein.^[16] To prevent nocturnal hypoglycemia, a typical meal plan includes 20% at breakfast, 30% at lunch, and 30% at dinner, with two 10% snacks at bedtime throughout the day.^[17] Dietitians recommend the following steps for simple carbohydrate counting: choose healthy foods, limit fat, pay attention to portion sizes, monitor carbohydrate intake, and record food portion sizes throughout the day.^[18]

This study aims to evaluate the effect of carbohydrate counting among children and adolescent with insulin dependent diabetes on their glycemic management.

2. PATIENTS AND METHODS

The study is an observational, descriptive, case series study. It was conducted between the 20th of September 2023 to the end of February 2025 at investigators private clinics in Mosul city. The study included 120 patients already diagnosed with insulin dependent diabetes mellitus among less than 18 years old.

The investigators conducted direct interviews with parents to complete self-administered questionnaires. The questionnaire was composed from two tools. The first tool is adolescent's assessment sheet; including patients' name, ages and gender. Also, it contained patients' past and present medical diabetes history; including diabetes duration, diagnosis, treatment, dietitian follow-up, complications, hospitalizations, and family history. Moreover; the study assessed blood glucose levels before and after meals, as well as glycated hemoglobin (HbA1c). Pre-prandial blood glucose levels were divided into three categories: low (less than 80 mg/dL), normal (equal to or greater than 80 mg/dL but less than 130 mg/dL), and high (equal to or greater than

130 mg/dL).^[19] Meanwhile, post-prandial blood glucose was categorized into two levels: normal level if post-prandial blood glucose is less than 180 mg/dL, and high level if post-prandial blood glucose is more than or equal to 180 mg/dL.^[20] HbA1C levels are classified into four levels: normal (more than 6% and less than 7%), moderate (more than 7% and less than 8%), high (equal to more than 8% and less than 9%), and very high (equal or more than 10%).^[20] The second Tool: which was taken from the American Diabetes Association, evaluates seven domains: four domains for carbohydrate detection and three domains for insulin dosage. The four domains of carbohydrate recognition are: (1) identifying carbohydrates; (2) counting the number of carbohydrates in specific foods; (3) counting the number of carbohydrates in entire meals; and (4) reading nutrition labels. While; The first of the three insulin dosing domains is the use of insulin dosage correction based on blood glucose levels; the second is the use of the insulin-to-carbohydrate ratio in insulin dosing; and the third is the calculation of the insulin dose for the entire meal.^[21] Each correctly answered question on the Pediatric Carb Quiz (PCQ) added one point to the final score. Answers that were very near to the right answer received partial credit (half point). Zero point was awarded for incorrect answers. Each component of the multi-part questions was treated as a separate item, and a correct response earned one point toward the final score. The final PCQ consists of 78 items. The highest possible score was 78/78 overall, with the highest possible scores of 20/78 in the insulin dosage domain and 58/78 in the carbohydrate identification domain. Higher scores signify a higher level of understanding regarding carb counting and insulin dosage. The information gathered was processed, categorized, and evaluated using relevant statistical significance tests. Statistical analysis was conducted using SPSS version 30.0 (SPSS Inc., Chicago, USA). Quantitative data were presented as mean \pm standard deviation. Qualitative data were presented as frequency and percentages. A p value of <0.05 was considered statistically significant.

RESULTS

The study includes 120 child and adolescent with insulin dependent diabetes mellitus. The mean age \pm standard deviation of the study participants is 14.53 ± 0.83 years. Male: Female ratio was 0.739.

Table 3.1 shows socio-demographic characteristics of the study participants. It's evident that the age group of 10-14 years was prevalent among 66 (55%) patients followed by the age group of 14-18 years among 31 (25.84%) and the age group of less than 10 among 23 (19.16%) patients. Moreover; 51 (42.5%) patients were males and 69 (57.5%) were females. Lastly; 91 (75.83%) patients reported positive family history of diabetes mellitus.

Table 3.1: Socio-demographic characteristics of the study participant. (number=120).

Variable	Number (=120)	Percent
Age (years)		
- Less than 10	23	19.16
- 10-14	66	55
- 14-18	31	25.84
Gender		
- Male	51	42.5
- Female	69	57.5
Family history of diabetes		
- Present	91	75.83
- Absent	29	24.17

Table 3.2 explores distribution of the study participants according to their diabetes past details. 56 (46.67%) of the study participants reported insulin dependent diabetes for more than 5 years (the mean \pm standard deviation was 6.129 ± 1.248 years). Additionally; 35 (29.17%) patients having it for 3-5 years and 29 (24.16%) patients suffered from it for less than 3 years. Moreover; concerning the patients' presentation at diagnosis; 40 (33.33%) patients had coma, 62 (51.57%) patients had hyperglycemic symptoms and only 18 (15%) had accidental diabetes

diagnosis. From the other hand; 107 (89.16%) of the patients received insulin alone while 13 (10.84%) patients received insulin and nutritional therapy. Furthermore; 58 (48.33%) patients reported hospitalization for different causes including; diabetic coma in 9 (15.52%), diabetic ketoacidosis in 38 (65.51%) patients and hypoglycemia in 11 (18.97%) patients. Lastly; only 12 (10%) of patients did dietitian consultation.

Table 3.2: Distribution of the study participants according to their diabetes past details. (number=120).

Variable	Number	Percent
Duration diabetes		
- Less than 3 years	29	24.16
- 3-5 years	35	29.17
- More than 5 years	56	46.67
Presentation at diagnosis		
- Coma	40	33.33
- Hyperglycemia symptoms	62	51.67
- Accidental diagnosis	18	15
Types of treatment		
- Insulin	107	89.16
- Insulin and nutritional therapy	13	10.84
History of hospitalization		
- Yes	58	48.33
- No	62	51.67
Reason for Hospitalization		
- Diabetic coma	9	15.52
- Diabetes ketoacidosis	38	65.51
- Hypoglycemia	11	18.97
Dietitian consultation		
- Yes	12	10
- No	108	90

Table 3.3 illustrates distribution of the study participants according to their diabetes assessment. 88 (73.33%) patients of the study participants were reported pre-prandial blood glucose of more than 130 mg/dL, versus 29 (24.17%) patients reported it in between 80-130 mg/dL and only 3 (2.5%) patients reported it less than 80 mg/dL. From the other hand; 79 (65.84%) patients reported post-prandial blood glucose of more 180 mg/dL. Lastly; the mean of glycated hemoglobin (%) was 9.83 ± 2.189 , distributed as the following; 9 (7.5%) patients were not did it, 2 (1.67%) patients had HbA1c of less than 6

(%), 31 (25.83%) patients had HbA1c of 6-8 (%), 49 (40.83%) patients had HbA1c of 8-10 (%) and 29 (24.17%) patients had HbA1c of more than 10 (%).

Table 3.3: Distribution of the study participants according to their diabetes assessment. (number=120).

Variable	Number	Percent
Pre-prandial blood glucose		
- Less than 80 mg/dL	3	2.5
- 80 – 130 mg/dL	29	24.17
- More than 130 mg/dL	88	73.33
Post-prandial blood glucose		
- Less than 180 mg/dL	41	34.16
- More than 180 mg/dL	79	65.84
Glycated hemoglobin (HbA1C)		
- Not done	9	7.5
- Less than 6 %	2	1.67
- 6-8%	31	25.83
- 8-10%	49	40.83
- More than 10%	29	24.17

Table 3.4 shows the means and standard deviations of different PCQ score, the mean \pm standard deviation of carbohydrate recognition domain was 41.49 ± 10.73 ,

while the mean \pm standard deviation of insulin dosing domain was 23.01 ± 9.21 . The mean \pm standard deviation of total score was 31.03 ± 9.91 .

Table 3.4: The means and standard deviations of different PCQ score (number=120).

Total Pediatric Carb Quiz score	Mean \pm standard deviation
Carbohydrate recognition domain	41.49 ± 10.73
Insulin dosing domain	23.01 ± 9.21
Total score	31.03 ± 9.91

Table 3.5 reveals the correlation between glycemic control parameters and total PCQ score among the study participants. Mild negative correlation was founded between all of the glycemic control parameters (pre and

post prandial blood glucose, random blood sugar and glycated hemoglobin) and total PCQ score, with no statistically significant difference (p value >0.05) for all.

Table 3.5: The correlation between glycemic control parameters and total PCQ score among the study participants. (number=120).

Parameters of glycemic control	Total Pediatric Carb Quiz score	
	Correlation	P value
Pre-prandial blood glucose	-0.128	0.532
Post-prandial blood glucose	-0.198	0.639
Random blood sugar	-0.094	0.525
Glycated hemoglobin	-0.121	0.243

3. DISCUSSION

Carbohydrate counting is a diet management strategy that can help children and adolescents with insulin dependent diabetes understand blood glucose patterns and provide flexibility when selecting foods. Dietary management, particularly carbohydrate management, is the primary factor affecting post-meal blood glucose levels in insulin dependent diabetic patients.

In this study, the correlation between carbohydrate counting and glycemic outcomes is studied among 120 participants with insulin dependent diabetes mellitus in order to confirm the hypothesis of carbohydrate counting can improve the glycemic outcomes. However, this is the first study examined such correlation among children and adolescent in Mosul city.

The majority of the study participants were from the age group of 10-14 years old with female being the

predominant gender, comparable results were obtained from Asma Deeb *et al.*^[22] From the other hand; three quadrants of the study participant founded to have positive family history of diabetes mellitus which is goes with Dalia Abdel Mordy Baiomy *et al* study findings.^[23] The current study founded that the mean duration of diabetes among the study participant was about 6 years, more than half of them had hyperglycemia at time of presentation, about 90 % were received insulin only and another 90% were not consult dietitian, additionally; almost half had hospitalization history with DKA was the commonest cause of hospital admission, however; adolescents with insulin dependent diabetes might not take their insulin as prescribed and lack parental supervision are responsible for the higher hospitalization rate and incidence of DKA episodes. Furthermore, hypoglycemic or hyperglycemic problems and repeated hospitalization are caused by inadequate food control. these results are parallel to Beatriz Diniz

GABRIEL *et al.*^[24] but not consistent with Müge Arslan *et al.* studies results.^[25]

The majority of the study population founded to have poor glycemic control marked by high pre and post-prandial blood sugar and glycated hemoglobin levels, which is comparable to the study findings of Osman Son *et al.*^[26] and Viviane M Dias *et al.*^[27] studies' findings. The results of the current study indicated that the PCQ total score was relatively low. The findings oppose those of Muskaan Gurnani *et al.*^[28] The reason for the discrepancy is that, despite following up with a dietitian, adolescents with insulin dependent diabetes in this study still felt restricted. They also disliked the guidelines and looked for ways to feel free when making dietary choices, such as increasing their consumption of "fast food" while disregarding the estimation of carbohydrate content.

The results of the present study showed that in spite of having a negative but it was non-significant correlation between glycemic control and total PCQ score which is in same line of what was founded by Natalie Finner *et al.*^[29] but it was in different line with M. Mullen *et al.* study results.^[30]

The limitations of the current study should be considered when interpreting the results. First, because of the limited sample size, the results might not be as readily generalizable to other populations. Second, the study was conducted at two private clinics, which may have reduced the external validity of the results. Furthermore, the lack of extra HbA1c testing might have led to inaccurate measurements and reduced the accuracy of the study's findings.

5. Conclusions and recommendations

The findings of this study conclude that children and adolescents with insulin dependent diabetes had a low level of recognition with regard to the carbohydrate counting and that there was a negative but non-significant correlation between their total PCQ score and their glycemic control. Further studies with large sample size are needed for confirm the exact effect of carb counting on treatment of insulin dependent diabetes among children and adolescent.

Conflict of interest

The authors of this study report no conflicts of interest.

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