Original Research Article

Assessment of carbohydrate count and standard diabetic diet on children growth with type 1 diabetes

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ABSTRACT

Background: The management of optimal blood glucose levels in type 1 diabetes children is essential with proper nutrition therapy to achieve age-appropriate growth and development and to avoid acute and chronic complications.
Methods: One hundred type 1 diabetes aged between 6 and 18 years were on insulin with the duration of one year were enrolled in the study. The participants were divided into two groups of fifty in each. The control group received a standard diet and routine treatment and intervention group received carbohydrate-count diet in addition to standard care. Detailed history, anthropometric, biochemical, clinical examination and 3-day dietary intake were collected at baseline baseline, three months, and after six months.
Results: The intervention group exhibited significantly lower mean HbA1c levels than control group, indicating improved glycemic control. Categorizing patients into weight-for-age categories revealed a significant difference in distribution between control group at baseline (CG-38.6±11.9) and after six months (40.4±11.5), p=00024. In comparison, the intervention group showed a significant difference at baseline (IG-37.1±13.6) and after six months (39.4±13.6), p=00001. However, the intervention group showed more substantial improvement in weight gain. Although mean differences in BMI-SDS between control and intervention groups were observed.
Conclusions: Carbohydrate counting method showed significant improvement in glycemic levels in intervention group and intern reduced insulin requirement this could achieve the age-appropriate growth patterns in children with Type 1 diabetes.

Keywords: Children, Glycemic control, Type 1 diabetes

INTRODUCTION

Type 1 diabetes mellitus (T1DM) is caused by autoimmune damage of the insulin-producing beta cells of the pancreatic islets, usually leading to severe endogenous insulin deficiency.[1] T1DM accounts for approximately 5-10% of all cases of diabetes.[2] The etiology of T1DM is multi-factorial.[3] In diabetes, deficient insulin action on the target tissues results in carbohydrate, fat and protein metabolism abnormalities. Exogenous insulin therapy is essential to prevent fatal complications from hyperglycemia.[4] Medical nutrition significantly contributes to effective glycemic control. More intensive intervention is required to improve their awareness of nutrition education and diabetes education to achieve

optimal glycemic control.[5] The nutritional recommendation for children and adolescents with T1DM is the same as their peers, except for insulin therapy. This allows optimal growth, maintains an ideal weight and prevents acute and chronic complications. Indian food is heavily influenced by region, religion, traditions, seasons and cultural choices.[6] The carbohydrate counting approach is new to rural Indian patients. However, since the development of multiple daily insulin injections, the modification of pre-meal dosages based on the carbohydrate amount of meals has become a more standard procedure. Research on the impact of teaching carbohydrate counting on the nutritional status of children with type 1 diabetes is lacking in India.

Among the various dietary strategies for managing T1DM, carbohydrate counting and the standard diabetic diet are two commonly used approaches. Carbohydrate counting allows for precise insulin dosing based on carbohydrate intake, offering flexibility in food choices while maintaining blood glucose control. In contrast, the standard diabetic diet emphasizes balanced meals with controlled carbohydrate intake, focusing on consistency in meal patterns to regulate blood sugar levels. Children with T1DM face unique challenges in maintaining nutritional adequacy, growth and glycemic stability. While carbohydrate counting provides greater dietary freedom, its impact on overall nutritional status compared to the standard diabetic diet remains a subject of this study assesses their effectiveness in maintaining appropriate growth parameters, dietary adequacy and glycemic control by comparing these two approaches, thereby contributing to evidence-based dietary recommendations for children with T1DM.

Objectives

To evaluate the impact of carbohydrate counting and standard diabetic diet on the nutritional status of children with T1DM.

METHODS

Study design

The present study is a randomised controlled trial.

Study place

The research study was conducted at Department of Pediatrics–R.L. Jalappa Hospital and Research Center, SDUAHER, Tamaka, Kolar, Center for Diabetes and Endocrine care - A unit of Dr. Prasanna and Dr. Sanjay Associates, Bangalore, Department of Endocrinologist, Mazumdar Shaw Medical Center, Bommasandra, Bangalore.

Study duration

This study was conducted from April 2023 to June 2024.

Sample size

Children between the ages of 6 and 18 who were interested in participating were asked to read the patient information sheet and fill out the written consent form. Children between the ages of 12 and 18 were also required to sign a written assent form in addition to their parents' or legal guardians' written consent form. The research included 100 patients receiving insulin treatment who had diabetes for at least one year.

No patients were using insulin pumps. Participants on a split mix or twice-daily insulin regimen switched to a basal-bolus regimen once they adjusted to the change and were included in the study. There have been few randomized controlled trials (RCTs) conducted on this subject.

Inclusion criteria

Children diagnosed with T1DM for more than one year and between the age group of 6 years and 18 years, were included in the study.

Exclusion criteria

T1DM children with co-morbidity were excluded from study. Children/adolescents were excluded if they had T1DM for less than 1-year, celiac disease or medications (other than insulin) which will affect their blood glucose levels (e.g., steroids). Subjects who were reluctant to sign in consent form was excluded.

Procedure

Participants aged between 6 to 18 years, receiving insulin treatment for one year, were recruited using the block randomization technique with a block size of 4 and were randomized into control (n=50) and intervention (n=50) groups using block randomization. The total recruitment included 100 children.

Control group

he participants of the control group received routine medical care, along with usual outpatient nutrition education recommended by the ISPAE. The approximate energy intake and essential nutrients were distributed, Carbohydrates 55-60%, fat 30-35 or protein 10-15 %.

However, the 2017 guidelines recommend a proper diet which promotes optimal growth, maintains an ideal weight and prevents acute and chronic complications. Guidance was given by a registered dietitian with dietary education and two follow-up sessions.

Intervention group

The intervention group participants underwent a structured nutrition education intervention for over 3 months. The

method of carbohydrate counting education was implemented with the standardized tool for the intervention group in four sessions. The intervention programme comprised one face-to-face session and three online sessions, each lasting 45 minutes, conducted by a Registered Dietitian. Reinforcement of the CHO method was performed during the follow-up visits for the participants and caregivers.

The material used for providing carbohydrate counting

Majoring on cups, standardized recipes and carbohydrate exchanges by food demonstration, visual aids and actual food packets to teach nutrition label reading. Standardized and validated questionnaire used for data collection.

Detailed history, anthropometric measurements, biochemical parameters, clinical examination and 3-day 24-hour dietary intake data were collected at baseline, 3rd month and 6th month (end of the study period) (Flow diagram 1). 100 children with type 1 diabetes mellitus meeting the inclusion criteria completed the questionnaires and were recruited in the study and both groups' demographic and anthropometric variables demonstrated similar distributions.

RESULTS

Table 1 explains that participants in the study included 30 boys and 70 girls. The age range of the study participants was 6 to 18 years, with a mean age of 12.4 ± 3.2 years. There was no significant difference between boys and girls concerning their level of education (Table 1).

Table 2 explains that average intake of carbohydrates in a 3-day 24-hours dietary recall among children in the control and intervention group was 284.8 ± 32.3 and 268.0 ± 34.4, respectively, $p=0.728$. The post-baseline levels after six months in the control group (283.4 ± 28.5) and intervention group (260 ± 26.14), $p=0.003$, showed a significant reduction in carbohydrate intake and a significant increment of fibre intake in the intervention group (Table 2).

One-way analysis of variance (repeated measure at different time points) $p<0.05$ significance (Table 3). The present study results indicate the growth parameters weight, height and BMI of children in both the control group (CG) and intervention group (IG) at baseline, 3-month follow-up and 6-month follow-up.

Repeated measures ANOVA indicate significant improvements over time across all measured parameters in both groups ($p<0.05$).

At baseline, the mean weight was comparable between the control group (35.3 ± 12.1 kg) and the intervention group (35.0 ± 12.6 kg). Over time, both groups showed an increase in weight, with the IG demonstrating a slightly greater increase by the 6-month follow-up (37.8 ± 12.5 kg vs. 37.6 ± 11.9 kg in CG). The F values (41.48 for CG and 79.08 for IG) indicate a statistically significant time effect, suggesting that weight gain was more pronounced in the intervention group.
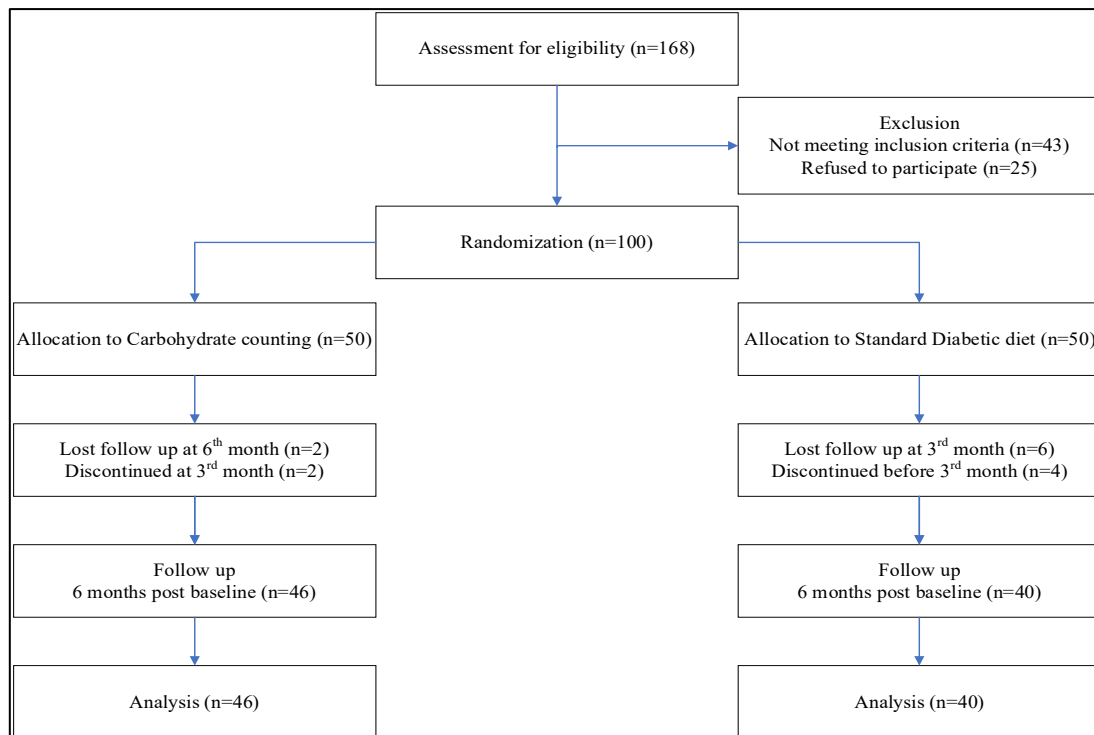

Figure 1: Enrolment of the subjects in the research study.

Both groups showed a gradual increase in height over the study period. At baseline, the mean height was 141.1±16.4 cm for CG and 141.1±15.8 cm for IG. By the 6-month follow-up, the IG (143.7±14.5 cm) and CG (143.8±15.2 cm) exhibited similar growth patterns. The F values (40.27 for CG and 77.47 for IG) suggest that height gain was significant over time in both groups.

BMI also increased progressively over the study period in both groups. At baseline, the BMI was 16.9±3.1 kg/m² for CG and 17.1±3.5 kg/m² for IG. By the 6-month follow-up,

BMI increased to 17.6±2.9 kg/m² in CG and 17.8±3.4 kg/m² in IG. The F values (12.39 for CG and 22.61 for IG) and significant p values indicate that BMI changes were statistically meaningful over time, with a relatively higher increase in IG. The findings indicate significant increases in weight, height and BMI in both groups over time. However, the intervention group showed slightly superior gains in weight and BMI, suggesting a positive impact of the intervention. The highly significant p-values ($p < 0.00001$) support that these changes were the result of an intervention.

Table 1: Baseline characteristics of the study participants.

Parameter	Control Group (Girls-33, Boys-17) n=50		Intervention Group (Girls-37, Boys-13) n=50	
	Mean±SD	Me (Q1-Q3)	Mean±SD	Me (Q1-Q3)
Age (in years)	12.8±3	13 (11-15)	12.1±3.4	12 (10-16)
Girls	13.1±3	14 (12-15)	12.1±3.4	12 (9.8-15.3)
Boys	11.6±2.8	11 (10-14)	12.2±3.6	12 (10-16)
Height (cm)	142.4±16	149 (133.5-156.6)	141±16.2	141 (126.5-153)
Girls	143.6±14.9	146 (131-155)	140.8±15.6	145 (126-153)
Boys	140±18.1	140 (129-155)	141.3±18.5	140 (128-147)
Weight (Kg)	35.7±11.6	40.9 (28.7-48.2)	35.5±12.9	32.3 (25.9-43.5)
Girls	37.9±11.9	44.7 (38.4-51.5)	35.5±13	31 (26-47)
Boys	31.5±10.1	31.7 (23.9-38)	35.6±13.6	33 (23-40)
BMI (Kg/m²)	17±3	16.5 (15.4-16.5)	17.3±3.5	16.6 (14.8-19.3)
Girls	17.8±2.9	17 (15.8-19.8)	17.3±3.8	16.4 (14.7-19.4)
Boys	15.3±2.4	15.7 (14.4-16.6)	17.2±2.6	16.9 (15.2-19.2)

Table 2: Average nutrient intake per 24-hour dietary based on 3-day recall mean values among children in the CG and IG at baseline and follow-up at 6 months.

Timeline	Groups	Energy kcal	Carbohydrate gm	Protein gm	Fat gm	Fiber gm
Baseline (Mean± SD)						
Average of 3-days	CG	1816.2±189.3	284.8±32.3	34.0±8.2	43.21±6.4	5.2 ±1.0
	IG	1752.3±208.7	268.0±34.4	33.8±7.86	41.8±7.4	5.3±1.1
P value		0.244	0.07	0.928	0.457	0.728
Follow up at (6 months) (Mean±SD)						
Average of 3-days	CG	1865.9±171.3	283.4±28.5	36.3±7.7	44.2±5.9	6.5±1.4
	IG	1813.7±163.4	260±26.14	40.2±9.5	44±8.2	8.3±1.7
P value		0.257	0.003	0.104	0.918	<0.001

* CG-control group, *IG-Intervention group.

Table 3: Growth parameters among children in the control and intervention groups at baseline and during follow-up.

Parameters	Groups	Baseline Mean±SD	Follow-up (3 months) Mean±SD	Follow-up (6 months) Mean±SD	F value	P value
Weight (cms)	CG	35.3±12.1	36.6±11.9	37.6±11.9	41.48387	<0.00001
	IG	35±12.6	36.4±12.6	37.8±12.5	79.0837	<0.00001
Height (Kgs)	CG	141.1±16.4	142.6±15.8	143.8±15.2	40.26508	<0.00001
	IG	141.1±15.8	142.7±15.2	143.7±14.5	77.4703	<0.00001
BMI (kg/m²)	CG	16.9±3.1	17.4±2.9	17.6±2.9	12.3893	0.00002
	IG	17.1±3.5	17.4±3.3	17.8±3.4	22.610	<0.00001

DISCUSSION

This study aimed to assess the influence of carbohydrate counting and the standard diabetic diet on the growth of children with type 1 diabetes over six months. The findings indicate that both groups experienced significant increases in weight, height and BMI, with the intervention group showing slightly greater improvements in weight and BMI. These results suggest that dietary management strategies, particularly carbohydrate counting, may have a positive impact on growth parameters in children with type 1 diabetes. Carbohydrate counting is widely recognized as an effective dietary strategy for children with type 1 diabetes, as it allows for more precise insulin adjustments and better glycemic control.[7] Improved blood glucose regulation minimizes catabolic episodes, which can otherwise lead to weight loss and impaired growth.[8] The slightly greater increase in BMI observed in the intervention group suggests that carbohydrate counting may contribute to better nutritional balance, preventing excessive weight loss and promoting healthy weight gain in children with type 1 diabetes.[9] This suggests that structured nutritional guidance regardless of the method used plays a crucial role in supporting growth in children with type 1 diabetes.[10] However, the slightly greater gains in the intervention group highlight the potential advantages of individualized dietary approaches like carbohydrate counting, which provides flexibility while ensuring appropriate nutrient intake and glycemic control.[11] Previous studies have shown that longer follow-up periods are needed to observe significant differences in growth trajectories among children with type 1 diabetes.[12] Future research with extended study durations and larger sample sizes is necessary to validate these findings. Long-term studies are necessary to determine whether carbohydrate counting provides sustained benefits for growth and metabolic health in children with type 1 diabetes. Additionally, assessing other markers such as glycemic variability and body composition could provide deeper insights into the effectiveness of different dietary strategies.[13]

The study findings suggest that both carbohydrate counting and the standard diabetic diet support growth in children with type 1 diabetes, with carbohydrate counting showing a slight advantage in weight and BMI gain. While the results are promising, longer-term studies are needed to fully understand the impact of dietary interventions on growth and overall health outcomes in this population.

This study's findings are promising; however, future research involving larger sample sizes and extended study durations is essential to validate these results and gain a comprehensive understanding of the long-term impact of dietary interventions on growth and overall health outcomes in this population.

CONCLUSION

Evidence supports the recommendation of carbohydrate counting over the standard diabetic diet in children and adolescents with type 1 diabetes mellitus. HbA1c values in the intervention group improved significantly, demonstrating better glycemic management. A weight gain was found among the carbohydrate-counting group. Carbohydrate counting reduced insulin requirements in this study, helping to achieve age-appropriate growth patterns in T1DM children.

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