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DIETARY INTAKE AND COMPLIANCE WITH RECOMMENDED NUTRITION STANDARDS IN CHILDREN WITH TYPE 1 DIABETES: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Objective: Medical dietary therapy is a critical component of Type 1 Diabetes (T1D) management. This study assessed adherence to International Society for Pediatric and Adolescent Diabetes (ISPAD) 2018 dietary guidelines among children with T1D. **Materials and Methods:** A cross-sectional study was conducted in the Pediatric Clinic of Gayatri Vidya Parishad Institute of Healthcare & Medical Technology (GVPIHC & MT), Visakhapatnam, Andhra Pradesh, over an 18-month period (April 2023–October 2025). Nutritional evaluation was performed for 75 children diagnosed with T1D. **Results:** Adherence to ISPAD dietary recommendations was observed in 40% of participants. The mean (SD) percentage contribution of daily calories from carbohydrates, fats, and proteins was 51.93 (6.08) %, 32.42 (5.66) %, and 15.95 (2.45) %, respectively. Sixty-eight percent of children consumed >10% deviation from their Estimated Average Requirement (EAR). Compared with the non-adherent group, children classified as adherent consumed fewer calories from carbohydrates [50.26 (2.11) % vs 53.18 (7.39) %], maintained saturated fat intake <10%, and had a higher proportion of protein-derived calories [16.74 (1.68) % vs 15.42 (2.75) %] ($P < 0.05$). Mean HbA1c (%) levels were significantly lower among adherent children [7.5 (0.50) vs 9.17 (1.12)]. **Conclusions:** A substantial proportion of Indian children with T1D do not meet ISPAD dietary recommendations. Non-adherence was marked by greater intake of carbohydrates and saturated fats and lower protein intake. Children who adhered to dietary recommendations showed better glycemic control, emphasizing the need for strengthened nutritional education and individualized dietary counselling.

INTRODUCTION

Medical nutritional therapy is a key component in the management of children with Type 1 Diabetes (T1D). These children do not require a restrictive or special diet; instead, dietary recommendations align with principles of healthy eating applicable to all children.[1,2] According to the 2018 International Society for Pediatric and Adolescent Diabetes (ISPAD) guidelines, carbohydrates, fats, and proteins should contribute approximately 45–55%, 30–35%, and 15–20% of the total daily energy intake, respectively. Intake of sucrose and saturated fatty acids should each be limited to no more than 10% of total calories.

Despite these guidelines, several challenges persist. Ensuring adequate dietary diversity and nutritional sufficiency across age groups, while maintaining optimal glycemic control, is difficult in many settings. Additional concerns include achieving adequate micronutrient intake, reducing consumption of sweetened beverages and processed foods, and fostering long-term healthy eating habits. Ideally, meal planning for children with T1D should be individualized based on age, sex, daily routine, activity levels, social circumstances, and pubertal stage.

Insulin dosing is ideally guided by the carbohydrate content of meals along with pre-prandial blood glucose levels. However, limited availability of trained healthcare professionals capable of teaching

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carbohydrate counting and insulin adjustment often restricts this individualized approach. In practice, caregivers frequently rely on fixed insulin doses assuming a relatively constant carbohydrate intake per meal. Overcrowded outpatient clinics further contribute to insufficient nutritional counselling and caregiver education.[3]

This study was conducted to evaluate dietary patterns of children with T1D attending a tertiary care centre and to assess their adherence to ISPAD dietary recommendations. It also examined the relationship between nutritional adherence and glycemic control.

MATERIALS AND METHODS

This cross-sectional study was conducted in the pediatric outpatient clinic of Gayatri Medical College and Hospital (GVPIHC & MT), Vishakhapatnam, Andhra Pradesh, over 18 months (April 2023–October 2025). Children aged 5–18 years with type 1 diabetes (T1D) for ≥1 year, attending the clinic at least twice annually, and without recent acute complications (DKA, symptomatic hypoglycemia, or infection within the preceding 4 weeks) were included. Those with comorbidities affecting dietary intake (e.g., celiac disease or chronic illnesses) were excluded. Written informed consent was obtained from parents and assent from adolescents. Institutional Ethics Committee approval was secured. Assuming an adherence rate of 54% to dietary recommendations among children with T1D,[4] with a precision of 10% and a 95% confidence interval, the required sample size was calculated to be 96. All enrolled participants were evaluated using a pre-structured proforma. Socioeconomic status was assessed using the Modified Kuppuswamy Socioeconomic Scale.[5] Anthropometric measurements were interpreted using age- and sex-specific growth references formulated by the Indian Academy of Pediatrics.[6] Dietary intake was assessed using a 24-hour dietary recall method, which documented the type and quantity of foods and beverages consumed on the day preceding the interview. In instances where the previous day involved atypical dietary patterns (such as a feast or fast), the interview was rescheduled to the subsequent visit to ensure representative intake information.

Dietary history was obtained from the primary caregivers and from adolescents themselves, wherever applicable. Nutrient composition for each child's dietary intake was calculated using the DietCal software program.[7] Total daily energy intake was estimated, along with the proportion of calories derived from carbohydrates, proteins, fats, saturated fatty acids, and sucrose. Caloric requirements were determined using the Estimated Average Requirement (EAR) for age and sex as per the Indian Council of Medical Research (ICMR)–National Institute of Nutrition (NIN) guidelines.[8] Energy intake within ±10% of the EAR was categorized as adequate, whereas intake >10% above or below the EAR was classified as excess and deficient energy intake, respectively.

Participants who met all ISPAD 2018 macronutrient intake criteria were classified as adherent to dietary recommendations.[1] HbA1c levels were measured for all enrolled children at the time of recruitment. Dietary diversity was evaluated using the Minimum Dietary Diversity for Women (MDD-W) scale,[9] with a score ≥5 (consumption of at least five of the ten defined food groups on the previous day) indicating adequate dietary diversity. All participants underwent assessment of hemoglobin and fasting lipid profile (after a minimum fasting duration of 8 hours). Anemia was defined as hemoglobin levels below age-specific thresholds recommended by the WHO.[10] Dyslipidemia was diagnosed when one or more lipid parameters exceeded age-specific reference ranges.[11]

Statistical Analysis: Data analysis was performed using SPSS software version 16. Descriptive statistics were used to summarize the study variables, and results are presented as percentages and means or medians with corresponding measures of variability. The Chi-square test was applied to compare categorical variables, while an unpaired Student's t-test was used to compare continuous variables between the adherent and non-adherent groups. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 75 children with T1D were enrolled, of whom 57% were boys, with a mean (SD) age of 9.9 (3.3) years. The study was conducted over an 18-month period at Gayatri Medical College and Hospital (GVPIHC & MT), Visakhapatnam, Andhra Pradesh (April 2023–October 2025). The median (IQR) duration of diabetes follow-up was 26 (15–48) months. A majority, 41 participants (54.7%), belonged to the lower-middle socioeconomic class.

The mean (SD) weight-for-age and height-for-age Z-scores were –0.08 (1.24) and –0.17 (1.30), respectively. Overweight/obesity was observed in 26.7% of children. The mean (SD) HbA1c was 8.5 (1.29) %.

Assessment of dietary adequacy showed that 68% had an energy deficit, whereas 5.3% consumed excess energy. The mean (SD) proportions of total calorie intake derived from carbohydrates, proteins, and fats were 51.93 (6.08) %, 15.93 (2.45) %, and 32.42 (5.66) %, respectively. Diets of 30 children (40%) met overall ISPAD 2018 macronutrient recommendations. Adherence to recommended carbohydrate and protein intake was observed in 48 (64%) and 47 (63%) participants, respectively. All participants had sucrose intake within recommended limits, with a mean (SD) intake of 11.5 (7.4) g/day. However, only 33 children (44%) consumed fat within the recommended range (Table I).

A higher than recommended proportion of energy intake from saturated fatty acids (SFA) and trans-

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fatty acids (≥10%) was observed in 32 children (42.7%). Dietary fibre intake was adequate in 61 participants (80.5%), with a mean (SD) intake of 29.4 (8.4) g/day. Sixty-seven children (89.3%) met the criteria for adequate dietary diversity. Anemia and dyslipidemia were seen in 33 (44%) and 12 (16%) participants, respectively. No significant association was found between dietary adherence and variables such as age, sex, duration of diabetes, number of clinic visits per year, frequency of SMBG, insulin regimen, socioeconomic status, or parental education (Table II).

Children classified as adherent demonstrated significantly lower percentage of daily energy intake from carbohydrates [50.26 (2.11) % vs. 53.18 (7.39) %], lower saturated fat intake (<10%), and a higher proportion of energy intake from protein [16.74 (1.68) % vs. 15.42 (2.75) %], compared with the non-adherent group (P < 0.05) (Table III). Mean HbA1c (%) was also significantly lower among adherent children [7.5 (0.50) vs. 9.17 (1.12)], indicating better glycemic control.

Table 1: Assessment of Energy Intake from Various Macronutrients in Comparison to ISPAD 2018 Recommendations Across Various Age-groups in Children (n = 75)

Age group (Years)	Carbohydrate intake			Fat intake			Protein intake		
	Adequate	Deficient	Excess	Adequate	Deficient	Excess	Adequate	Deficient	Excess
5–6 (n=11)	7 (64)	1 (9)	3 (27)	3 (27)	5 (45)	3 (27)	6 (55)	3 (27)	2 (18)
7–9 (n=26)	16 (62)	0	10 (38)	13 (50)	9 (35)	4 (15)	14 (54)	12 (46)	0
10–12 (n=23)	15 (71)	1 (7)	7 (31)	15 (65)	4 (17)	4 (17)	14 (76)	5 (24)	0
13–15 (n=15)	9 (60)	4 (27)	2 (13)	5 (33)	6 (47)	4 (20)	10 (67)	4 (27)	1 (6)
16–18 (n=2)	1 (50)	1 (50)	0	1 (50)	1 (50)	0	1 (50)	1 (50)	0
Total	48 (64)	7 (9)	20 (27)	33 (44)	24 (32)	18 (24)	47 (63)	25 (33)	3 (4)

Values expressed as n (%)

Table 2: Assessment of Determinants of Adherence to Dietary Guidelines

Variables	Categories	Adherent Group (n=30)	Non-adherent Group (n=45)	P value
Gender	Male	15 (50.0)	28 (62.2)	0.294
	Female	15 (50.0)	17 (37.8)	
Age (years)a	5–9	15 (50.0)	22 (48.9)	0.691
	10–12	10 (33.3)	12 (26.7)	
	13–15	4 (13.3)	11 (24.4)	
	16–18	1 (3.3)	0 (0.0)	
Age (years) (mean ± SD)b	—	9.97 (3.11)	9.93 (3.3)	0.965
Duration of T1D (mo) (median IQR)c	—	26.0 (20.25, 55.50)	25.0 (15.0, 46.0)	0.862
Socioeconomic status	Upper class	1 (3.3)	0 (0.0)	0.662
	Upper middle	9 (30.0)	13 (28.9)	
	Lower middle	10 (33.3)	14 (46.7)	
	Upper lower	8 (17.8)	5 (16.7)	
	Lower	1 (2.2)	3 (3.3)	
Education of father	Illiterate	7 (23.3)	3 (6.7)	0.084
	Primary + middle	13 (43.3)	17 (37.8)	
	Secondary + senior	8 (26.7)	23 (51.1)	
	Graduate	2 (6.7)	2 (4.4)	
Education of mother	Illiterate	6 (20.0)	11 (24.4)	0.228
	Primary + middle	15 (50.0)	13 (28.9)	
	Secondary + senior	7 (23.3)	19 (42.2)	
	Graduate	2 (6.7)	2 (4.4)	
Insulin regimen	Glargine + regular	24 (80.0)	37 (82.2)	1.00
	NPH + regular	6 (20.0)	8 (17.8)	
Self-monitoring of glucose per day (median, IQR)c	—	3 (3,4)	4 (3,4)	0.513
Number of follow-up visits per year (median, IQR)c	—	8 (5,10)	10.0 (6.0,11.0)	0.219

Values expressed as an(%), bmean (SD),cmedian (IQR)

Table 3: Dietary Variables in Children Classified as "Adherent'' and "Non-adherent'' to ISPAD Recommendations

Dietary Variable	Adherent (n=30)	Non-adherent (n=45)	P value
Proportion of energy from carbohydrates	50.26 (2.11)	53.18 (7.39)	0.010*
Proportion of energy from fats	33.44 (1.90)	31.74 (7.10)	0.133
Proportion of energy from proteins	16.74 (1.68)	15.42 (2.75)	0.012*
Proportion of energy from sucrose	3.05 (1.87)	2.63 (1.57)	0.290
Adequate fibre intake	23 (76.67)	38 (84.44)	0.397
Energy from SFA > 10%	3 (10)	29 (64.44)	<0.001
HbA1c (%)a	7.50 (0.50)	9.17 (1.12)	<0.001
Dyslipidaemia	3 (10.0)	9 (20.0)	0.341
Anaemia	10 (33.30)	23 (51.10)	0.129

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Data is presented as n (%) or [a] *mean (SD)*

SFA Saturated fatty acid

DISCUSSION

The present study, conducted over 18 months at Gayatri Medical College and Hospital (GVPIHC & MT), Visakhapatnam, assessed adherence to dietary recommendations among Indian children with T1D attending regular follow-up at a tertiary care centre. Overall, 60% of participants were non-adherent to ≥1 of the ISPAD 2018 dietary recommendations. Children in the non-adherent group reported a higher proportion of calories from carbohydrates and saturated fats, whereas protein-derived calories were comparatively lower. Importantly, children who adhered to dietary guidelines demonstrated significantly better glycemic control, reflected by lower mean HbA1c values compared with their non-adherent counterparts.

Nearly two-thirds of the study population had an energy deficit ≥10% below the recommended intake according to age- and sex-specific ICMR-NIN requirements.[8] Such deficits may be attributed to multiple contextual factors common in Indian households, including socioeconomic constraints, larger family size, cultural feeding practices, food fads, and consumption of low energy density diets. Interestingly, despite 68% of children having an energy deficit and only 5.3% consuming excess calories, 26.7% were overweight or obese. This paradox may indicate imbalance in macronutrient distribution rather than absolute caloric excess, suggesting that diet quality and composition may play a more substantial role than total calorie intake alone.

Consistent with this observation, adherent children consumed fewer calories from carbohydrates [50.26 (2.11) % vs. 53.18 (7.39) %] and saturated fat (<10%), and a greater proportion from proteins [16.74 (1.68) % vs. 15.42 (2.75) %] compared with non-adherent children ($P < 0.05$) (Table III). The significantly lower mean HbA1c in the adherent group [7.5 (0.50) % vs. 9.17 (1.12) %] underscores the positive impact of dietary adherence on glycemic control in children with T1D.

This seemingly discordant observation can be explained by the fact that BMI is influenced not only by dietary intake, but also by genetic predisposition, lifestyle factors, and environmental influences. In the present study, only 40% of children achieved appropriate macronutrient distribution as per ISPAD recommendations. Studies from China and Australia have similarly reported difficulty in meeting these dietary targets among children with T1D.[12,13] Although the traditional Indian diet is generally high in carbohydrates, nearly two-thirds of children in our cohort met the recommended carbohydrate intake, a finding that contrasts with the STARCH study, where adults with type 2 diabetes in India were found to consume disproportionately high carbohydrate (65–70%) and low protein (10–12%) diets.[14] This favorable trend in our participants may reflect the impact of regular, individualized dietary counselling and structured diabetes education delivered by certified diabetes educators at our centre. However, it is notable that one-fourth of the children consumed excess total fat, and more than 40% exceeded the recommended intake of saturated and trans-fatty acids.

The observed inappropriate dietary patterns may be attributed to increased consumption of junk and street foods, many of which are high in total fat—particularly saturated and trans-fatty acids—as well as refined carbohydrates. Easy accessibility, aggressive marketing, and peer influence likely contributed to frequent snacking and unhealthy food choices among children. Protein intake was below recommended levels in one-third of participants, contrasting with dietary trends reported from Western populations, where protein consumption tends to be higher.[15] According to updated ISPAD 2022 recommendations, carbohydrates, fats, and proteins should account for 40–50%, 30–35%, and 15–25% of total daily energy intake, respectively, with emphasis on fiber-rich foods of low glycemic index and moderate glycemic load.[16]

Children who adhered to dietary guidelines demonstrated better glycemic control, evidenced by significantly lower HbA1c levels. Dietary analysis in this group showed a lower intake of carbohydrates and saturated fats and a higher proportion of calories from protein compared to the non-adherent group. Interestingly, no significant association was found between diet adherence and variables such as age, sex, diabetes duration, clinic follow-up frequency, SMBG frequency, insulin regimen, socioeconomic status, or parental education. The absence of association may reflect an inadequate sample size to detect such relationships.

The present study provides valuable insight into dietary patterns among Indian children with T1D and highlights existing gaps in adherence to ISPAD recommendations

What This Study Adds?

- A large proportion of Indian children with T1D do not meet ISPAD dietary recommendations. Non-adherent children consumed a higher proportion of calories from carbohydrates and saturated fats, and a lower proportion from proteins.
- Adherence to dietary guidelines was associated with significantly better glycemic control.

Limitations: The study was limited by a relatively small sample size, which may have reduced the ability to detect associations between adherence and sociodemographic or clinical variables. Glycemic index and glycemic load of the consumed diet were not evaluated, which may have further influenced glycemic outcomes. Additionally, reliance on a

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single 24-hour dietary recall may not accurately reflect habitual dietary patterns over time.

CONCLUSION

This study highlights the dietary composition of Indian children with T1D and reveals notable deviations from ISPAD-recommended macronutrient distribution. Adherence to dietary guidelines was associated with significantly better glycemic control, emphasizing the need for continued dietary education and structured nutritional support in the management of pediatric T1D.

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