

## Original Research Article

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# Assessment of nutritional status and carbohydrate counting according to insulin dosage among type 1 diabetes mellitus



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## ABSTRACT

Type 1DM requires careful management of blood glucose levels, often achieved through insulin therapy and dietary management. CC is a cornerstone of diabetes management, enabling individuals to estimate carbohydrate intake and adjust insulin doses accordingly. Accurate CC is crucial for effective glycemic control, preventing both hyperglycemia and hypoglycemia. The longitudinal study was conducted on 10 children and adolescents for 3 months, who were selected from OPD, IMS, BHU, Varanasi. The aim is to calculate their carbohydrate, protein, and fat intake as well as the insulin dose recommended by the doctor. Data was collected through self-structured questionnaire. From the data analysis, carbohydrate, protein, and fat intake by children is low, but carbohydrate intake in adolescents is high, that is, >130g/day, while protein and fat intake are low. It shows that the nutritional status of children and adolescents is low, for which they are coming under underweight, the common factor that affects the nutritional status are due to lack of knowledge and low income in their families. So it is concluded that optimum protein and fat amounts should be included in their diet to come under normal BMI. However, the study faced certain challenges, including a small sample size and short study duration, and difficulties in obtaining accurate dietary information.

**Keywords:** Adolescent, children, carbohydrate counting, BMI, socioeconomic status, carbohydrate: insulin ratio, insulin dose, food consumption pattern, nutrient intake.

## Introduction

T1DM is increasing in children and adolescents by about 3-5% per year[1]. T1DM is characterized by hyperglycaemia due to little or no insulin production by the pancreatic  $\beta$  cell. Insulin metabolizes carbohydrates to produce energy. Infection, stress, physical injury, and surgery are the causative factors of T1DM. The underlying mechanism involves an autoimmune destruction of the beta cells in the pancreas. The classic symptoms are hyperglycaemia, glycosuria, excess urination, excess thirst, excess hunger, ketonuria, fatigue, and reduction in weight.

CC is a carbohydrate-counting method that involves the grams of carbohydrate required in the diet, which will help in weight gain, glycemic control, and determining insulin dose. According to a study, found that by CC, weight gain was seen among girls[2]. Carbohydrate foods have a greater impact on blood sugar level than other likewise, insulin dose can be adjusted based on the amount of carbohydrate. Carbohydrate counting can be done by meal planning, learning which food contains carbohydrate, and using measuring tools. So to know the intake of carbohydrate in grams, one has to divide the number of calories wanted from carbohydrates by 4, and the amount of carbohydrate resulting needs to be spread at each meal throughout the day.

This helps in adjusting the insulin for carbohydrate and keeps the blood glucose level close to target levels. Carbohydrate counting may improve metabolic control and reduce HbA<sub>1c</sub> concentration[3]. Faulty CC is associated with higher blood glucose variability[4].

## Materials and Methods

A longitudinal study was conducted in S. S. Hospital, IMS, BHU, Varanasi on 10 Children for 3 months, bearing the age group 5-18 years. Data was collected through self-structured questionnaire and an interview method. Before data collection, the study purpose was made clear to respondents, and their content was taken to prevent any response bias.

The questionnaire was divided primarily into 3 parts: general information, specific information, and dietary and nutritional data. General information provides information about different respondents like age, gender, education, family size, parents' occupation, family type, socioeconomic status. Specific information consists of specific questions about their number of meals, height, weight, BMI, family history, duration of disease, duration of blood glucose level check up, and frequency and dosage of insulin. Dietary assessment information provides information about their dietary habit, food consumption patterns by food frequency questionnaire, their likes or dislikes, vegetarian or non-vegetarian. The dietary recall method was used to record last 24 hours food taken. BMI was calculated by using the WHO scale. And their socio-economic status was calculated by the kuppuswamy socioeconomic scale[5]. Their carbohydrate intake and insulin dosage were calculated, and assessed whether the amount of carbohydrate intake is adequate according to their insulin dosage.

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## Result and Discussion

Out of 10 study participants, 5(50%) were children and 5(50%) were adolescent. Based on gender, 6 (60%) study participants were boys, while 4 (40%) were girls. So, from the study it was found that boys are more prone than girl. To determine socioeconomic status, based on occupation, education of family head, and family income found that 90% of them belonged to lower-class families and only 10% belonged to the upper lower class status. From the study, only 20% had having family history of diabetic. According to a study, 37% of T1DM cases showed family history[6].

According to WHO, BMI was calculated, and about 70% were severely underweight (BMI is <16), 10% were moderate underweight (BMI is between 16 to 16.99), and 20% were mild underweight (BMI is between 17 to 18.49). According to a study, clinical signs such as unintentional weight loss, excess hunger, thirst, and urination lead to underweight during diagnosis in children and adolescents[7]. From the study, it is also found that about 20% were non-vegetarian (includes red meat and fish), 40% egg-eaters and 40% vegetarians.

About 60% children insulin frequency is 3 times/day, while 40% insulin frequency is 2 times/day. Only 30% goes for a monthly check-up while 70% goes for a medical check-up when needed.

**Table 1: Distribution of the respondents in % based on their food consumption pattern**

Food Groups	Frequency(%)			
	Daily	Weekly	Occasionally	Never
Cereals				
Rice	100	-	-	-
Roti	100	-	-	-
Pulses and legumes	100	-	-	-
Roots and tubers	-	30	70	-
Other Vegetables	100	-	-	-
Fruits	40	-	60	-
Green leafy vegetables	50	-	50	-
Milk and milk products	80	-	-	20
Flesh food	-	-	20	80
Egg	-	40	-	60
Sugar	-	-	-	100
Jaggery	-	-	100	-

Food consumption patterns were studied by a food frequency questionnaire. Table 1 shows that 100% participants were taking roti as well as rice (cereals), pulses, legumes and other vegetables. 40% of participants were taking fruit daily, while 60% consumed it occasionally. 80% participants were consuming milk daily, while 20% never took milk. About 30% participants were consuming roots and tubers weekly and 70% participants occasionally. 100% never took sugar but all children were consuming jaggery occasionally such as during festival to replace sugar. 50% participants were taking green leafy vegetables alternatively, while 50% were taking them occasionally. Only 20% participants were taking flesh food occasionally, while 40% participants consumed egg alternatively.

**Table 2: Average nutrient intake by children and adolescent**

Nutrients	Children	Adolescent
Carbohydrate	107.6±8.4g	140.9±11.5g
Protein	45.7±5.64g	52.1±6.83g
Fat	16.5±3.3g	23.18±6.6g

Nutritional status of children and adolescents was assessed by 24-hour recall methods and their average intake by using mean±SD. As per the 2018 ISPAD Guideline, the intake of calories and essential nutrients should be planned to support and maintain an individual's ideal body weight. So the calories from carbohydrate, protein, and fat intake should be 45-50%, 15-20% and <35% (saturated fat 10%) respectively[8].

In T1DM, energy requirement is determined by tracking weight, BMI and growth patterns on paediatric growth charts[9]. From Table 2 mean daily protein and fat intake by children is 45.7±5.64g and 16.5±3.3g, while the mean daily adolescent protein and fat intake is 52.1±6.83g and 23.18±6.6g, respectively. Mean daily carbohydrate intake by children and adolescents is 107.6±8.4g and 140.9±11.5g, respectively. According to researcher study, carbohydrate intake should be <130g per day, if weight loss and prevention of both hypo- and hyperglycemia are a concern[10].

**Table 3: Insulin to carbohydrate ratio of children and adolescent**

Respondents	Carbohydrate(mean±sd)	Insulin(mean±sd)	I:C ratio
Children	107.6±8.4g	14.22±5.3units	1:7.57
Adolescent	140.9±11.5g	16.54±8units	1:8.52

Children and adolescents mean insulin injection according to the mean daily carbohydrate intake is 14.22±5.3units and 16.54±8units. So, Table 3 depicts the insulin to carbohydrate ratio in children is 1:7.5 which means 1 unit of insulin is used to metabolize 7.57 grams of carbohydrates. And in adolescents insulin-to-carbohydrate ratio is 1:8.52, which means 1 unit of insulin covers to metabolize 8.52 grams of carbohydrate.

## Conclusion

This study underscores the compromised nutritional status among children and adolescents diagnosed with T1DM, with a significant proportion(70%) found to be severely underweight. While carbohydrate intake among adolescents exceeded the recommended 130g/day, protein and fat consumption remained consistently below the ideal levels in both age groups. These dietary inadequacies appear closely linked to socioeconomic constraints, limited nutritional knowledge and restricted food variety.

The calculated insulin-to-carbohydrate ratios were approximately 1:7.5 for children and 1:8.52 for adolescents, emphasizing the importance of accurate carbohydrate counting(CC) to match insulin dosage. Additionally, the predominance of vegetarian dietary patterns and infrequent consumption of animal-based proteins may have contributed to suboptimal protein intake and associated weight loss.

Therefore, comprehensive dietary strategies that promote sufficient protein and healthy fat intake, combined with structured education on carbohydrate counting and insulin management, are critical for achieving better glycemic control and improving the nutritional health of T1DM patients. Continuous dietary assessment and individualized meal planning can support healthy weight gain and assist in attaining optimal BMI in the vulnerable population.

## Future scope of the study

Further studies should incorporate biochemical markers, such as HbA1c and continuous glucose monitoring data to strengthen the link between nutrient intake and metabolic control. And can also examine the impact of socioeconomic and psychosocial factors on nutritional status, and test tailored interventions aimed at improving protein and fat intake to support healthy growth and BMI.

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#### Conflict of Interest

The author declares that there is no conflict of interest related to this study. No financial, personal, or institutional relationship have influenced the design, data collection, analysis, or reporting of this research.

#### Ethics Statement

The study was conducted in accordance with ethical standards. Informed consent was obtained from all participants and their guardians prior to data collection.

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