Review Article

Nutritional Guidelines for Patients with Type 1 Diabetes Mellitus and its Adherence- A Narrative Review

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Abstract

Nutritional guidelines are of importance in directing food choices of T1D patients. The objective is to summarise existing nutritional recommendations and examine its adherence by T1D patients. Literature was searched on dietary guidelines in T1D using electronic databases PubMed, Science Direct, Scopus, Google Scholar, in English and 29 papers were selected. As per ADA, EASD, ISPAD, and ICMR guidelines, energy recommendations for T1D are based on ideal body weight to prevent overweight and obesity. The safe amounts of carbohydrates, protein and fat includes 50–55%, 15–20% and 25–30% of total energy respectively with fiber intake recommended at 20–30 g/day. Vitamin and mineral supplementation are beneficial in the presence of deficiency. Adherence to nutritional recommendations was suboptimal but better in those who were frequently consulting a dietician. As suboptimal dietary adherence leads to poor glycaemic control, nutritional guidelines must be followed to manage T1D and prevent or delay diabetic complications.

Keywords: Dietary adherence, nutrient intake, nutrient recommendations, nutritional guidelines, Type 1 Diabetes (T1D)

Introduction

Diabetes is a serious, chronic disease that occurs either when the pancreas does not produce enough insulin, or when the body cannot effectively use the insulin, it produces.[1] Raised blood glucose, may over time lead to serious damage to the body's organs.[2] T1D is also on the increase like Type 2 diabetes, even though not in the same proportion, with a trend of 3–5% increase/year.[3] In 2021, there were about 8·4 million individuals worldwide with T1D: of these 1·5 million (18%) were younger than 20 years, 5·4 million (64%), 1·6 million (19%) were aged 20–59 years and 60 years or older, respectively.[4] The incidence and prevalence of T1D in Asia were 15 per 100,000 population and 6.9 per 10,000 people, respectively.[5] A recent study found an incidence of 4.9 cases/100000/year in India.[6] As per IDF 10th edition, India now has the highest estimated number of prevalent T1D cases in people under 20 years of age (229,400), followed by the USA (157,900) and Brazil 92,300.[7]

Dietary adherence is also an important factor in diabetes management to prevent further progression of complications. Studies by Jaworski (2016)[8] and Mirahmadizadeh *et al*., (2020)[9] stated that patients' non-adherence to recommendations was related to a low level of disease acceptance. They find it challenging to introduce changes in their diet and lifestyle. Similarly, adherence to diet recommendations is still low compared to medication advice. It is estimated that about 50% of the patients do not adhere to nutrition advice properly. Hence, this paper attempts to present an overview of the existing nutritional recommendations to manage T1D and the significance of dietary adherence to achieve better glycemic control.

Objective- To provide a summary of existing nutritional recommendations/guidelines for people with T1D and examine the dietary adherence by patients to the same.

Access this article online

Quick Response Code:

Website: https://journals.lww.com/indjem/

DOI: 10.4103/ijem.ijem_104_24

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Submitted: 28-Mar-2024 **Revised:** 15-Jul-2024
Accepted: 31-Aug-2024 **Published:** 08-Nov-2024

How to cite this article: Kaushik A, Rekhi TK, Puri S, Tandon N. Nutritional Guidelines for patients with Type 1 diabetes mellitus and its adherence- A narrative review. Indian J Endocr Metab 2024;28:461-9.

Methodology

A literature search that encompassed articles on existing nutrition guidelines published in English between 2002 and 2022 was conducted using electronic databases PubMed, Science Direct, Scopus and Google Scholar. Keywords used for the search included "Type 1 diabetes and/or dietary guidelines", "Type 1 diabetes mellitus and/or diet/dietary adherence", "Type 1 diabetes mellitus and/or dietary habits," "Type 1 diabetes mellitus and/or nutritional guidelines," "Type 1 diabetes mellitus and/or nutritional recommendations," "diabetes management and/or type 1 diabetes mellitus," "Type 1 diabetes mellitus and/or nutrition management. We used MeSH terms as keywords for searching. References in the papers were also explored. Based on the keywords search, 558 papers were identified; after screening based on title and abstract, 152 were selected. Finally, 29 studies were eligible for the current review as described in Figure 1.

Inclusion criteria – Studies explored the nutrition guidelines or dietary management and its adherence in patients with T1D published between 2002 and 2022 and available in English.

Exclusion criteria – Studies that were not published in English, articles not exploring nutrition and its related aspects, involved animal subjects, and patients with conditions that cofound nutrition management or its adherence were excluded.

Results

Major recent dietary guidelines that exist [Table 1] for T1D are those developed by the American Diabetes Association [ADA 2004, 2008, 2013, 2018, 2019, 2021], the International Society for Pediatric and Adolescent Diabetes [2014, 2018, 2022], (ISPAD), EASD[2004] and Indian Council of Medical Research, [ICMR, 2022].

Dietary management

These guidelines primarily focused on the maintenance of normoglycemia, optimal blood pressure, weight, and lipid levels, facilitating healthy growth and development, prevention of development or progression of complications, and maintenance of good quality of life. MNT is associated with HbA1c reductions of 1.0–1.9% for people with T1D.[10]

Energy

To provide adequate energy to ensure normal growth and development, ICMR stated that the energy requirements for children and adults with T1D are similar to the general population.[11] In children and adolescents, energy needs can be evaluated by tracking weight gain, BMI, and growth patterns on paediatric growth charts.[12] It was observed that the normal-weight preschool T1D children have better glycaemic control than age-matched overweight children.[13] A study comparing the energy intake of children with diabetes with that of matched control subjects reported that the intake of children with diabetes fell below that of control subjects who met the RDA.[14] Another study by Helgeson *et al*.[15] in 2006 showed that adolescents with diabetes took in less total energy than recommended. Hence the basis for energy recommendations would be the determination of ideal body weight to prevent overweight and obesity among the patients and encourage optimal growth and development. According to Sharma *et al*. (2020),[16] Indian diets are unhealthy, across states and income groups. As there is an excess consumption of cereals and not enough proteins, fruits, and vegetables. Importantly, excess consumption of animal protein is not a problem in India. So, the focus should be on a balance between fats, carbohydrates, and proteins together.

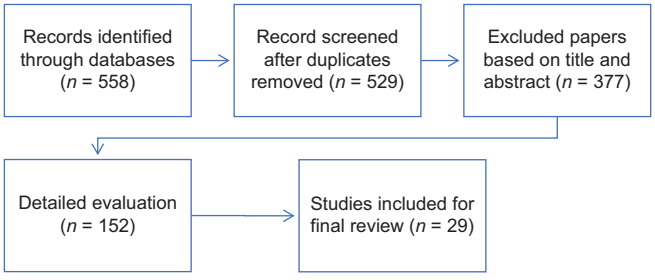

Figure 1: Flow chart of studies inclusion schema

Carbohydrates

It has by far the maximum effect on plasma glucose levels. Thus, monitoring the intake of carbohydrates is important to control postprandial glucose fluctuations, which may lead to clinical benefits such as a reduction in glucose variability, improvement in HbA1c levels, and a reduction in complications.[17] As per the National Health and Medical Research Council recommendations for the management of T1D in Australia, patients are advised to consume carbohydrates to the level of 45–65% of total energy intake.[18,19] In 2021, guidelines ADA suggests that macronutrient distribution should be based on an individualized assessment of current eating patterns, personal preferences (e.g., tradition, culture, religion, health beliefs and goals, and economics), and metabolic goals.[20] Whereas, in 2014 ADA guidelines stated that "there is no ideal percentage of calories from carbohydrate for all people with diabetes.[21] Similar recommendations were retained in the 2019 guidelines as well.[10] While the ADA Standards of Medical Care in Diabetes (2018) recommend 45–60% energy from carbohydrates.[22]

In 2022 and 2018, ISPAD recommended that carbohydrates should contribute 40–50% of total energy whereas, it was 50-55% in 2014.[23-25] Also, the consensus report from ADA and EASD (European Association for the Study for Diabetes) stated that while low-carbohydrate and very low-carbohydrate eating patterns have become increasingly popular and reduce HbA1c levels in the short term, it is important to incorporate these in conjunction with healthy eating guidelines.[26] ICMR has launched Indian Nutrition guidelines for T1D in the year 2022 in which they have recommended that carbohydrate intake should be 50–55% of total calories. As cereal-based diets are the staple for Indians, this higher level of carbohydrate makes diets easier to adhere to. Moreover, too much carbohydrate restriction may hamper growth in children and adolescents and

Table 1: Nutritional guidelines to manage type 1 diabetes mellitus

Guidelines	Year	Energy	Carbohydrate	Protein	Fat	Fibre
ADA	2004	Reduced energy intake and modest weight loss improve insulin resistance and glycemia in the short term.	Carbohydrate and monounsaturated fat together should provide 60–70% en. Individuals receiving fixed daily insulin doses should try to be consistent in day-to-day carbohydrate intake.	15–20% of total daily energy	Less than 10% of energy intake should be derived from saturated fats. Dietary cholesterol intake should be <300 mg/day. Polyunsaturated fat intake should be ~10% of energy intake	Large amounts of fiber suggested a positive effect on glycemia
	2008	Weight loss is recommended for all such individuals who have or are at risk for diabetes	130 g/day is an average minimum requirement. Monitoring carbohydrates, whether by CC and exchanges a key strategy in achieving glycemic control. The use of GI and GL may provide a modest additional benefit over that observed when total carbohydrate is considered alone	Does not exceed 20% of energy intake	Saturated fat to <7% of total calories. Intake of *trans* fat should be minimized. Limit dietary cholesterol to <200 mg/day	High-fiber diet (~50 g fiber/day)
	2013	Modest weight loss may provide clinical benefits in some individuals with diabetes.	The amount of carbohydrates and available insulin should be considered when developing the eating plan	Evidence is inconclusive to recommend an ideal amount of protein intake for optimizing glycemic control therefore, goals should be individualized	Evidence is inconclusive for an ideal amount of total fat intake for people with diabetes; therefore, goals should be individualized; fat quality appears to be far more important than quantity	Similar consumption as recommended for the general public.
	2018	Management and reduction of weight	45–60% of total energy intake. Education on how to use CC and in some cases fat and protein gram estimation to determine mealtime insulin dosing is recommended to improve glycemic control.	1–1.5 g/kg body weight/day or 15–20% total calories	20–35% of total energy intake	NA
	2019	Management and reduction of weight is important	The ideal amount of carbohydrates is inconclusive. Monitoring carbohydrate intake and blood glucose response to dietary carbohydrates are key for improving postprandial glucose control. A consistent pattern of carbohydrate intake with respect to time and to improve glycemic control and reduce the risk of hypoglycemia. While, people are encouraged to decrease both sweetened and nonnutritive-sweetened beverages and use other alternatives, with an emphasis on water intake.	15–20% from protein	Mediterranean-style diet rich in MUFAs and PUFAs may be considered to improve glucose metabolism	Minimum of 14 g of fiber per 1,000 kcal)

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Table 1: ***Contd...***

Guidelines	Year	Energy	Carbohydrate	Protein	Fat	Fibre
ISPAD	2014	Energy intake and essential nutrients should aim to maintain the ideal body weight	50–55% of total energy. Carbohydrate counting is best introduced at the onset of type 1 diabetes.	15–20% of total energy	30–35% of total energy	NA
	2018	Energy intake and essential nutrients should aim to maintain the ideal body weight	45–50% of total energy. Fixed insulin regimens require consistency in carbohydrate amount and timing to improve glycemic control and reduce the risk of hypoglycemia. Water should always be taken instead of drinks sweetened with non-nutritive sweeteners.	15–20% of the daily energy intake	<35% of energy (saturated fat <10%	NA
	2022	Energy intake and essential nutrients should aim to maintain the ideal body weight	40–50% of total energy	15–25% of the daily energy intake	<35% of total energy and saturated fat should be <10%	NA
EASD	2004	Overweight (BMI > 25 kg/m^2) calorie intake should be reduced so that BMI moves towards the recommended range. weight loss may lead to a reduction in insulin dose and improved glycemic control	45% and 60% total energy	In patients with no evidence of nephropathy (10–20% total energy). Evidence of established nephropathy, (0.8 g/kg normal body weight/day).	Not more than 35% total energy	More than 40 g/day (or 20 g/1000 Kcal/day), about half of which should be soluble.
ICMR	2022	Similar to the general population	50–55% of total calories. Sucrose should be limited to less than 10% and preferably less than 5% of total calories. Also, commonly used non-nutritive and hypocaloric sweeteners can be used as per the acceptable daily intake	2 g/kg at one year, 1 g/kg at ten years 0.8–0.9 g/kg in adolescence	Up to 30% of total energy	14 g of fiber per 1,000 kcal ingested

hence should be discouraged. Even in adults, a minimum of 130 g of carbohydrates should be ensured per day to provide sufficient glucose as fuel for the brain.[11]

Lennerz *et al*. in 2018[27] conducted an online survey using a social media platform to evaluate glycemic control among adults and parents of children with T1D reported a mean daily carbohydrate intake of 36 ± 15 g, with excellent glycemic control (mean HbA1c was 5.67 ± 0.66%) with low rates of adverse events or severe hypoglycemia. However, the authors also mentioned that additional research is needed to determine the degree of carbohydrate restriction to achieve the mentioned benefits. In 2005, Nielsen[28] demonstrated that a daily intake of 70–90 g of carbohydrates significantly reduced hypoglycemic events and lowered HbA1c from 7.5% to 6.4% after 3 months. ADA 2014, suggests that glucose (15–20 g) is the preferred treatment for the conscious individual with hypoglycemia, although any form of carbohydrate may be used. Once blood glucose concentration returns to normal, the individual should consume a meal or snack to prevent the recurrence of hypoglycemia.[21]

Sweeteners: As per ICMR, 2022 guidelines, the use of sucrose should be limited to less than 10%, and preferably less than 5% of total calories, consuming high amounts of sugar in drinks may not be adequately covered with insulin, and hence, should be avoided. Along with this, the guidelines also stated the commonly used non-nutritive and hypocaloric sweeteners (saccharin, neotame, aspartame, acesulfame K, stevia, alitame, and sucralose). They are commonly used in low-sugar, 'light', or 'diet' products to improve sweetness and palatability and are also used to replace table sugar in cooking at home but in appropriate amounts.[11] Also, ADA (2019), stated that for those who consume sugar-sweetened beverages regularly, a low-calorie or nonnutritive-sweetened beverage may serve as a short-term replacement strategy, but overall,

people are encouraged to decrease both sweetened and nonnutritive-sweetened beverages and use other alternatives, with an emphasis on water intake.[10] ISPAD 2018, recommends that instead of drinks sweetened with non-nutritive sweeteners water should be encouraged.[23] Acceptable daily intake of non-nutritive sweeteners as per ISPAD 2022 (Sucralose 0–15 mg/kg body weight, Saccharin 0–5 mg/kg body weight, Acesulfame K 0–15 mg/kg body weight, Aspartame 0-40 mg/kg body weight, and Steviol glycosides 0–4 mg/kg body weight.[24]

Carbohydrate counting

Carbohydrate counting (CC) is a meal-planning tool for patients with T1D treated with a basal-bolus insulin regimen using multiple daily injections or continuous subcutaneous insulin infusion.[29] Some studies have shown that CC can have a positive effect on HbA1c and provide better blood glucose regulation, but the results vary between studies and more research is needed.[30-32] However, inaccurate CC is common and associated with higher daily blood glucose variability.[33] A study by Spiegel *et al*.[34] showed that adolescents with TID were not accurate in CC and often over- or under-estimated the number of grams of carbohydrates in a meal. Laurenzi *et al*.[35] conducted a randomized controlled study on adult patients using insulin pumps to investigate the effects of CC and demonstrated a statistically significant decrease in BMI and HbA1c values ($P = 0.05$) at the end of the 24th week. In a study done by Gupta *et al*., (2021)[36] in India, found that most patients were not taught CC, and those who were taught, did not practice it accurately. Moreover, as we know that South Asians have a carbohydrate dominant diet, CC may be beneficial for them to have optimal glycaemic control. As reported by Dimitriades and Pillay (2021) dieticians have agreed that is a useful dietary management approach to manage T1D. Whereas, barriers to using CC included a lack of training, confidence, experience, financial resources, time, blood glucose records poor patient motivation, and patient illiteracy.[37] Overall, CC has a positive effect on metabolic control, reduces hypoglycemia events, improves quality of life, and influences BMI. Further, it is the currently recommended nutrition approach alongside continuous blood glucose monitoring or self-monitoring of blood glucose.[38]

Glycemic Index and glycaemic load

GI is defined by the postprandial glucose excursion occurring after the ingestion of a carbohydrate-containing food compared with white bread or glucose.[39] The glycaemic load (GL) combines the GI and the total carbohydrate content of an average serving of a food. It was introduced as a measure of the overall effect of a food on blood glucose and insulin levels.[40] The literature concerning GI and GL in individuals with diabetes is complex often yielding mixed results, though in some studies lowering the GL of consumed carbohydrates has demonstrated HbA1C reductions of 0.2% to 0.5%.[41,42] Studies longer than 12 weeks report no significant influence of GI or GL, independent of weight loss, on HbA1c. However, mixed results have been reported for fasting glucose levels and insulin levels.[22] On the other hand, the findings of 11 randomized control trials reported that intake of low GI diets in diabetic management resulted in lower average HbA1c values and a reduced frequency of hypoglycemic and hyperglycemic events.[43]

Protein

Protein is the major functional and structural component of all cells of the body.[44] The consumption of proteins from both vegetarian and low-fat non-vegetarian sources, preferably in equal amounts, is recommended.[11] Nutritional recommendations for type 1 and type 2 patients from the Diabetes and Nutrition Study Group of the European Association for the Study of Diabetes in 2004 is 10 to 20% of total energy. As per ADA (2004 and 2019), there is no evidence to suggest that usual protein intake (15–20% of total daily energy) should be modified if renal function is normal. In 2019, they also suggested that the patients on dialysis, higher levels of dietary protein intake should be considered, since malnutrition is a major problem in some dialysis patients.[10,45] The 2013 ADA Standards of Care recommend an individualized approach to protein intake by considering factors like the metabolic status of the patient (e.g., lipid profile, renal function) and/or food preferences.[46] ISPAD 2018 and 2022, suggest that protein should cover 15–20% of the daily energy intake and also suggest that individuals with diabetes may need to make insulin adjustments to compensate for the delayed postprandial glycaemic excursions that can occur following high-protein meals.[47] Paterson *et al*.[48] showed that adding ≥28 g of protein to a mixed meal or consuming ≥75 g of protein by itself leads to significant and prolonged postprandial hyperglycemia in children and young adults aged 7–40 years. The National Kidney Foundation recommends 0.8 g protein/kg desirable body weight for people with diabetes and stages 1–4 chronic kidney disease as a means of reducing albuminuria and stabilizing kidney function.[49] According to ICMR 2022 guidelines, protein requirement in children and adolescents varies from 2 g/kg at one year, 1 g/kg at ten years to 0.8–0.9 g/kg in adolescence. Suggested protein intake is 15–20% of the caloric requirement. In patients with diabetic nephropathy, daily protein intake should not be restricted to less than 0.8 g/kg body weight to avoid the risk of malnutrition.[11] Protein sources (fish, milk, egg white, poultry, and meats) are of better quality as they provide all essential amino acids, but their use is associated with higher salt and saturated fat content. Remove the skin and visible fat while consuming the same. Whereas, proteins from vegetarian sources (soy, beans, and lentils) contain less SF and are rich in fiber and complex carbohydrates. Hence, the consumption of proteins from both vegetarian and low-fat non-vegetarian sources, preferably in equal amounts.[11] As stated by Delahanty and Weinstock the usual daily intake of protein should typically be 15–20% of total energy. Those with kidney disease should aim to maintain a dietary protein intake of 0.8 g/kg body weight per day.[50] International clinical guidelines now advise that people with T1D receive education on the glycaemic impact of fat and protein and tailor their insulin dose and delivery according to the total meal macronutrient composition.[51] Dual-wave insulin bolus, in which

insulin is calculated for both carbohydrates and fat proteins, is effective in controlling postprandial glycemia in patients on insulin pumps.[52,53] Although, a study stated that when the dose of insulin was increased for protein and fat content, significantly more episodes of hypoglycemia were observed and also indicated that there is no benefit to covering fat–protein meals with regular insulin in T1D treated with MDI.[54]

Fat

Diet composition affects glycaemic control, however the specific role of the intake of different nutrients is still a matter of debate, particularly the fat intake.[55] Even though clinical manifestations of CVDs generally appear in adulthood; the vascular damage might start early in T1D.[56] ICMR recommends a daily intake of fats up to 30% of total energy. For infants and children younger than two years of age it is upto35% of total energy. Intake of saturated fats (SF) should be limited to less than 10% and dietary cholesterol to less than 300 mg/day. In patients with raised LDL cholesterol, intake of SF should be restricted to 7% of total calories and 200 mg/day for SF and cholesterol respectively.[11] ISPAD guidelines in 2018 and 2022, recommended <35% of total energy and saturated fat should be <10%.[23,24]. In 2014 it was recommended that the approximate energy intake from fat should be 30–35%.[25] As per the Polish Diabetes Association fat should be 30-40% for children up to three years old and 30-35% for children over three years of age.[57] According to ADA 2004, total fat should contribute 25% to 35% of total energy, and SFA less than 10%.[45] While in 2018, it was 20–35% of energy from dietary fat.[22] ADA 2019, mentions that the ideal total dietary fat content is inconclusive, so an eating plan emphasizing elements of a Mediterranean-style diet rich in MUFAs and PUFAs may be considered to improve glucose metabolism and lower CVD risk.[10] A study by Mackey *et al*. (2018)[58] shows that a diet rich in fat and increased energy intake about daily demand hurts the metabolic control of diabetes. A cross-sectional study among 114 children and adolescents with T1D showed that with increasing SFA intake by 1% of total energy, the risk of having HbA1c >7.5% increases by 53%.[59] A more recent study confirmed that a higher MUFA intake lowered the risk of having an HbA1c higher than 7.5%.[60] The Diabetes Control and Complications Trial (DCCT) showed an association between higher HbA1c concentrations and higher SFA, MUFA, and total fat intakes.[61] Hence, it is useful to avoid the intake of a high-amount or poor-quality fat in diet to prevent its related complications.

Fiber

Higher intake of dietary fiber is associated with a lower risk of coronary heart disease, the leading cause of mortality among people with T1D.[62] Individuals consuming more than 5 fruits and vegetables servings/day had a 26% reduction in risk of stroke and a 17% reduction in risk of coronary heart disease compared with those consuming less than 3 servings/day.[63] Reynolds and colleagues in 2020 demonstrated that for people with T1D, a rise in the consumption of fiber from 19 to 35 g is an important component of their diet to see the improvements in glycemic measures.[64] Studies also revealed that foods rich in soluble fiber, such as beta-glucans, were shown to improve glycemia in diabetes patients.[65] ICMR and ADA recommend that the patients should consume 20 to 35 g of fiber from raw vegetables and unprocessed grains (or about 14 g of fiber per 1,000 kcal ingested).[11,20] The Nutrition Study Group of the European Association for the Study of Diabetes also mentioned that dietary fibers may delay glucose absorption and reduce postprandial glycemic excursion, which appears to have a beneficial effect on cholesterol level.[66]

Vitamin D

Vitamin D is a fat-soluble steroid and precursor for human steroid hormones. The recommended daily intake of vitamin D3 developed by the Endocrine Practice Guidelines Committee, is 400–1000 IU for infants, 600–1000 IU for children and adolescents aged 1–18 years, and 1500–2000 IU for adults.[67] A Swedish study carried out on 459 T1D patients, aged 15–34, demonstrated that the serum 25(OH) D concentration at diagnosis was significantly lower in people with diabetes as compared to the control group.[68] Another study among Australian children and adolescents with T1D also had significantly lower serum vitamin D concentration compared to healthy individuals.[69] Similar results that T1D patients had significantly lower 25(OH) D levels and higher prevalence of vitamin D deficiency compared to controls were reported by Daga *et al*.[70] and Federico *et al*.[71] in Indian and Italian case-control studies respectively. Even though there is no adequate evidence to recommend routine Vitamin D supplementation, it can be done in case of a deficiency.[10,72]

Minerals

As per ICMR (2022) and ADA (2019), recommendations for sodium intake in adults is 2300 mg (6.0 g salt) and intake should be limited to 1000 mg (2.5 g salt) in 1–3 years old children, 1200 mg (3 g salt) in 4–8 years old children, 1500 mg (3.8 g salt) for children and adolescents aged ≥nine years.[10,11] Intake of foods that are high in salt, should be limited. On the other hand, studies in people with T1D measuring urine sodium excretion have shown increased mortality associated with very low sodium intakes, potentially requiring caution for universal sodium restriction to 1,500 mg in the diabetes population without hypertension.[40] Vitamin and mineral supplementation are not beneficial lest there is any deficiency. People with diabetes should ensure meeting the RDA of the same through the diet by appropriate choice of foods and macronutrients.

Dietary adherence

Adherence is defined by the World Health Organisation as 'the extent to which a person's behavior - following a diet and/or executing lifestyle changes corresponds with agreed recommendations from a health care provider'.[73] Residence, monthly income, family history of diabetes, duration of diagnosis, duration of treatment, and previous exposure to dietary education were significant predictors of adherence to a dietary recommendation.[74] Apart from nutrition counseling, adherence to diet is an under-studied phenomenon.

As per Patton (2011),[75] suboptimal adherence to recommended dietary guidelines, is common in T1D patients. In a cross-sectional study of 817 T1D patients, Ahola *et al*.[76] reported that patients are consuming diets low in carbohydrates and fiber but high in fat. As per the recommendations, only 28 percent restricted SFA to less than 10 percent of their daily energy intake. Also, a higher intake of sucrose intake was reported.

Similarly, in a study with 101 T1D patients adherence behaviors were measured: number of calories consumed per day, frequency of meals, self-monitoring of blood glucose, amount of time between injections and meals, and frequency of exercise. Results revealed that almost half of the patients had HbA1c >10 percent. Patients had poor adherence behaviors in each aspect of diabetes management and overall glycaemic control as reflected by HbA1c levels was very poor.[77] Mohammed *et al*.[78] in 2019 concluded that more than half of 303 participants (55.7%) were nonadherent to the recommended dietary approach. Gathering with family and friends and eating out were the major reasons for not being compliant with the recommended regimen. A study published in 2012 revealed that among 187 adult patients with T1D, 51% consumed 45.1% of energy from carbohydrates, which is lower than the recommended range.[79] In clinical settings, adherence assessment can be an important gateway to identify when behavior change is needed and intervention is warranted.[80] Hence, dietary adherence is an essential component that needs to be considered to attain good glycaemic status among patients with T1D.

Regarding barriers to dietary adherence, Wangnoo *et al*., (2013),[81] in their review reported barriers like insulin related (multiple injections, inflexibility of regimen, pain), traveling and busy lifestyle of the patients, stress over changes in lifestyle and lifelong dependence on insulin, religious and cultural sensitivities like fasting, Low level of awareness of diabetes and its complications, lack of qualified diabetes educators, etc., Similarly, another study stated that time constraints related to work and study were the major hindrance to dietary compliance and lack of proper awareness about the importance of nutritional principles in diabetes. Other issues faced by a minority of patients include a lack of support from the family, work colleagues, and peers and affordability (Joseph *et al*., 2017).[82] Hence, this highlights the need for a patient-centric approach to diabetes care and effective monitoring and counseling of patients' adherence to the recommendations.

Conclusion

Predominantly, the guidelines that are present for T1D are of ADA, EASD, ISPAD, and ICMR. As observed during analysis most dietitians used the ADA dietary guidelines to manage T1D. As per the review and various studies, the safe amount of carbohydrates for T1D patients is 50% to 55% of total energy or not less than 130 g/day. Patients with diabetes should consume the same amount of protein recommended for people without diabetes, which is nearly 15–20% of the total energy if their renal function is normal. And should increase their protein content if on dialysis. For fat, the consumption can be between 25–30% of total energy. A total of 20–30 g/day of fiber should be consumed by patients with diabetes. For other vitamins and minerals, it is important to ensure that the RDA must be followed and no supplementation is required if there is no deficiency. Also, study findings suggested suboptimal dietary adherence among patients. Patients with T1D, who are consulting with a dietician as a part of their treatment plan might have better adherence to the recommended diet and in turn, have better glycaemic control. We understand that there is no standard meal plan or eating pattern that works universally for all people with diabetes. Nutrition therapy should be personalized based on the individual health goals, cultural preferences, health literacy and numeracy, access and readiness, willingness, and ability to change to be more acceptable and adhere to by the patients which will help them to elicit positive results, which will further delay their diabetes-related complications.

Author contributions

Review of article, manuscript preparation was done by AK. TKR, NT and SP were involved in review of the manuscript. AK, SP and NT were responsible for editing and finalizing the manuscript.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Data availability

Not applicable.

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