Review Article

Role of Macronutrients and Suitability of Upcoming Dietary Trends for Asian Adults with Type 2 Diabetes

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Abstract

Medical nutrition therapy interventions among type 2 diabetes patients administered by registered dieticians are said to be beneficial to the extent of reducing glycated hemoglobin by 1%–2%. Despite patient-centered dietary interventions, adherence continues to remain a challenge in the Indian setting due to the carbohydrate-rich dietary pattern, dietary myths coupled with lack of nutritional awareness, poor literacy, financial burden, and lack of motivation. On the contrary, the evolution of "FAD" diets through drastic dietary changes present individuals with type 2 diabetes with a possibility of reversal of the disease further increasing the nutritional dilemma. These FAD diets extend beyond being mere trends and show improvements in several biochemical processes by reducing the intake of calories either through restriction (very low-calorie diet) or fasting (intermittent fasting) or low carbohydrate diets up to one year. This article by evaluating the suitability of these promising diets to Indian adults with type 2 diabetes aimed to provide evidence that could improve diabetes-related dietary knowledge. Through this narrative review, we conclude that a single drastic dietary modification as seen in very low-calorie diets (≤ 800 kcal/day) or the low-carbohydrate diet (≤ 75 g/d) is not suitable for Indians and such dietary measures will further hamper the sustainability of prescribed diets. The future directions in diet and disease would be to develop clinical trials that will show the effectiveness of dietary regimens constituting optimal energy deficit and macronutrient balances that will contribute to the remission of disease while preventing macronutrient deficiencies and relapse in the dietary regimen.

Keywords: Asian Indian, calorie restriction, diabetes, low carbohydrate, suitable diet

Background

Diabetes is an ancient disease known since the times of the Egyptians and is also referred to in Ayurvedic texts.[1] Diabetes mellitus is described as a metabolic and vascular disorder characterized by increased blood glucose resulting from absolute or relative insulin deficiency combined with insulin resistance which leads to the affection of the small (microvascular) and large (macrovascular) blood vessels of the body.[2] The global burden of diabetes soared from 151 million in 2000 to 285 million in 2009 to a whopping 463 million adults in 2019.[3] The global burden of diabetes is projected to rise by 51% in 2045, and the projection for 2045 for the prevalence of diabetes is 700 million.[4] India has the second-largest number of people affected by diabetes with a prevalence of 77 million in 2019.[3] The 2013 sustainable goals of the United Nations have included reducing premature death due to noncommunicable diseases (NCDs) by one-third by 2030 as one of its goals.[5]

The importance of nutrition and diet therapy as the foundation for the treatment of diabetes mellitus is well recognized. Medical nutrition therapy interventions among type 2 diabetes patients administered by registered dieticians are said to be beneficial to the extent of reducing glycated hemoglobin (HbA1C) levels among patients by 1%–2% depending on the age and duration of disease.[6]

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However, the most challenging hurdle is compliance with the plan. Several studies have assessed the barriers in adherence to the dietary regimen in an Indian setting and outlined various factors besides the difficulty in reducing the dependency on carbohydrate-rich cereal staples. The population primarily lacked diabetes-related dietary knowledge to manage diabetes and achieve optimal metabolic parameters. Other causes of poor adherence to prescribed diet included ignorance, lack of motivation, associated financial burden, and negligence. Literacy levels significantly influenced adherence to the dietary regimen. Therefore, in a country where the incidence of diabetes is forecasted to increase among rural and economically disadvantaged, adherence could take a backseat if not for stringent community measures warranting sustainable lifestyle changes.[6-8] Moreover, different professionals have different ways of prescribing and there is no agreement on the best dietary or nutritional therapy for individuals with diabetes.[9] In this article, we will discuss the suitability of different diets for people with diabetes with an emphasis on India.

Prevailing Dietary Patterns in India

India is a unique country with several languages, cultures, and religions. Hence, there are diverse eating patterns in different parts of the country. In addition to the various civilizations, the neighboring countries such as Pakistan, Nepal, Bhutan, Sri Lanka, and Bangladesh have also influenced the dietary patterns of India.[10] Indian diets are cereal based and majority of the calories (approximately 60%–75%) come from carbohydrates as they mainly consume refined cereal (staples) such as white rice (WR) and wheat. Several studies have also shown that the commonly consumed Indian rice varieties are of the high glycemic index (GI).[11]

Nutritional epidemiological studies done at the Madras Diabetes Research Foundation have shown that higher refined grain consumption is significantly associated with the metabolic syndrome namely higher waist circumference, systolic blood pressure, diastolic blood pressure, fasting blood glucose, serum triglyceride, low high-density lipoprotein (HDL) cholesterol, and insulin resistance.[12] The Chennai Urban Rural Epidemiological Studies (CURES) study also showed higher body mass index (BMI) and body weight among the participants in the highest quartile as compared with the lowest quartile of refined grain intake with the average individual consuming 250 g of WR per day.[12] Approximately 46% of the energy was obtained from refined cereals, followed by 12.4% from visible fats and oils and 7.8% from pulses and legumes. It was observed that consumption of fruits and vegetables (265 g/day) and seafood (20 g/day) were lower than the Food and Agriculture Organization/World Health Organization (WHO) recommendations, whereas the dairy and meat products intake was within the nationally recommended intake. Studies on the dietary profile of the urban Indian population showed that carbohydrates were the major source of energy (64%), followed by fat (24%) and protein (12%). Similar findings were observed in the rural population also.[13] Studies showed that almost three-fourth of the calories (78.1%) came from carbohydrates. Lower intake of *n*-3 poly and monounsaturated fatty acids (MFAs) was also reported. These unhealthy dietary trends were likely contributed to the risk of NCDs such as diabetes in this population.[14]

Further studies showed that refined grain intake, total dietary carbohydrates, and glycemic load (GL) were associated with increased risk of type 2 diabetes, whereas population dietary fiber intake was inversely associated with diabetes.[15] Total carbohydrates and dietary GL was inversely associated with plasma HDL-cholesterol concentrations.[12]The higher dietary GL of Indian diets is due to the higher proportion of refined grains in the diet as they are starchy, contain higher levels of available carbohydrates or glycemic carbohydrates. In earlier studies, we have shown that sequential polishing of brown rice (BR) (unpolished rice), with a higher degree of polishing, the available carbohydrate content increases whereas the dietary fiber, health-beneficial phytochemicals, and antioxidants decreases.[14] We have also shown that the commonly consumed Indian rice varieties are of high GI.[11]

Improvements in socioeconomic status and urbanization have changed the eating patterns of people in India. In recent decades, consumption of snacks outside the house has increased considerably. These snacks are usually rich in refined vegetable oils. The easy availability of fast foods and snacks that are rich in fats has led to the increase in the consumption of trans fats, which are an important cause of insulin resistance and cardiovascular disease (CVD).[16,17] In addition to this, for every festive or family occasion sweets are included as an integral part of the food preparations. The ingredients used in the making of sweets are grains, sugar, milk, ghee (clarified butter), and oils. These make the preparations calorie-dense and so portion control of these preparations is very important as otherwise, there would be carbohydrate loading, which could increase the post-meal blood glucose levels.[10]

Macronutrients and Diabetes Mellitus

The American Diabetes Association (ADA)'s consensus statement of 2019 emphasizes the need for an individualizing diet to meet caloric goals with a macronutrient distribution that is more consistent with the individual's usual intake to increase the likelihood for long-term adherence.[18] Efforts to modify habitual eating patterns are often unsuccessful in the long term as people generally go back to their usual macronutrient distribution. An ideal mix of macronutrients does not seem

to exist but optimal calories to attain weight management goals have been identified as the key approach in tackling and achieving the goals of diabetes management.[19] However, the metabolism of all three macronutrients is influenced by insulin and so it is important to understand the most effective means of combining the macronutrients to influence the healthy eating patterns required for the management of diabetes.

Carbohydrates

Carbohydrates are the main macronutrient of concern in tackling hyperglycemia.[19]

Glycemic index and glycemic load

GI and GL rank carbohydrate foods according to their effects on glycemia.[20] GI is the property of food that measure the carbohydrate quality of a given food based on the glycemic response or in other words the ability of the food to raise the blood glucose levels.[21] On the contrary, GL provides a summary of the relative glycemic impact of a serving of food.[20] One of the best approaches to lower the GL of diets would be either to reduce the carbohydrate content or to consume foods with a lower GI.[22] Consuming foods with a lower GI would be a practically feasible approach as reducing the total carbohydrate content in Indian diets poses challenges, as they are mostly cereal staple based. In this context, it is shown that BR-based diets elicit a 20% lower day-long glycemic response as compared with WR-based diets in Asian Indians.[22,23] Long-term intervention studies have shown that substitution of WR with BR lowers HbA1c in participants with metabolic syndrome.[24] Thus, including whole grains and improving the quantity of pulses and legumes, fruits, and vegetables, which have a lower GI, will help to reduce the burden of type 2 diabetes in India.

Dietary fiber

Foods containing higher amounts of dietary fiber are usually those with a lower GI. The National Institute of Nutrition (NIN) recommends 30 g of dietary fiber every 2,000 kcal in its 2020 recommendations for dietary allowances for healthy adults,[25] which is similar to the ADA's recommendation of 14 g per 1,000 kcal for people with diabetes.[20] Dietary fiber can be of two types: insoluble and soluble fiber.[26] A meta-analysis was conducted to identify the effects of dietary fiber on the glycemic profile of adults with type 2 diabetes and the study published results that increased fiber intakes reduced HbA1c (mean difference [MD] −2.00 mmol/mol, 95% confidence interval [CI] −3.30 to −0.71 from 33 trials), fasting plasma glucose (MD −0.56 mmol/L, 95% CI −0.73 to −0.38 from 34 trials), and insulin (standardized mean difference [SMD] −2.03, 95% CI −2.92 to −1.13 from 19 trials).[27] A study conducted among Japanese adults with type 2 diabetes established that increased intakes of dietary fiber were associated with improvements in lipid profile and favorable outcomes related to CVD and chronic kidney disease.[28]

Resistant starch

Resistant starch is the starch that escapes digestion in the small intestine only to be fermented by colonic bacteria. Resistant starch unlike other types of starch cannot be broken down to form glucose and so it does not cause spikes in the blood glucose levels. Resistant starch provides satiety thereby reducing its consumption and thus contributing to weight management. It also has beneficial effects on insulin response by lowering the GI of foods and improves gut health.[29] Resistant starch has further been studied in comparison with digestible starch in relation to glycemic control and significant improvements were seen in fasting plasma glucose in the former group. Furthermore, the effect size was greater when the quantity and duration of intake were increased.[30]

Protein

Protein as a macronutrient is less researched among people with diabetes and pre-diabetes.[22] The amount of protein intake recommended for diabetic patients is confusing as the ADA recommends a certain percentage of calories from protein, whereas there are recommendations to calculate absolute grams of protein per kg bodyweight of the individual. The position paper of the ADA states a few studies that compared higher protein intakes with normal intakes (30% vs. 15%, 25%–32% vs. 15%–20%) and concludes that although higher protein diets contribute to greater weight loss, there is no difference in HbA1C levels.[31] The ADA recommends people with diabetes with normal kidney function consume 15%–20% of total calories from protein or 1.5 g/kg bodyweight/day and 0.8 g/kg bodyweight for diabetic patients with kidney disease.[32]

Fat

Dietary fats have been studied as a key contributor to obesity diabetes, hypertension, and CVD.[33] India has experienced a major transition in the dietary pattern, with a large increase in the consumption of fat.[34] Eating the right amount and type of fat is integral to various bodily functions. The National Academy of Medicine suggests that 25%–30% of total calories must be from fat for healthy individuals.[22] The 2020 Recommended Dietary Allowances for Indians given by NIN recommends a visible fat intake of 25, 30, and 40 g/day for sedentary, moderate, and heavy activity performing adult men and 20, 25, and 30 g/day for adult women as against the single level recommended earlier.[25] The ADA recommends including more monounsaturated and polyunsaturated fats than saturated or trans fats in the diet. In addition to restricting saturated and avoiding synthetic trans fats,

the primary goal is also to consume lower quantities of cholesterol.[35]

Cholesterol

The two sources of cholesterol are dietary cholesterol and the cholesterol produced by the body. Dietary cholesterol does not necessarily contribute to the detrimental effects of cholesterol as the body only absorbs small amounts of it. The body also makes its own cholesterol for various functions including the making of hormones, cell structures, and vitamin D. Increase in serum cholesterol levels contributes to a greater risk for developing heart disease. Foods that contain cholesterol levels are those foods that increase saturated and trans fats.[22]

Saturated fatty acid

Saturated fatty acid (SFA) increases low-density lipoprotein (LDL) cholesterol levels and so is to be consumed in limited quantities. Fats derived from animals are usually high in SFA. SFA increases the blood cholesterol more than the dietary cholesterol per se. The CURES study showed that intake of SFA more than 9% energy was also associated with an increased risk of diabetes.[33] Hence, < 7% calories from SFA is recommended. The primary source of SFA in India includes the use of ghee (clarified butter) and butter in cooking.[32]

Monounsaturated fatty acid

MUFA is considered a healthy fat because of its protective effect on cardiac health. MUFA should contribute between 10% and 15% of the total calories of fat. In metabolic studies, diets that are lower in saturated fats or enriched with *cis* monounsaturated fats reduced LDL cholesterol levels. Diets that are higher in monounsaturated fats lowered blood glucose levels and LDL cholesterol levels and increased HDL cholesterol levels.[35] However, MUFA-rich diets did not bring a difference in the HbA1C levels. In another study among Asian Indian adults showed that the intake of 7% MUFA significantly decreased the risk of diabetes as against PUFA and SFA that increased the risk. MUFA can be included in the diet but substituting animal sources of visible fat with olive or canola oil and by including nuts and seeds as a snack or garnish while keeping portion sizes optimal.[33] Groundnut and mustard oil are rich sources of MUFA.

Polyunsaturated fatty acid

The two types of polyunsaturated fatty acid (PUFA) are omega-3 fatty acids and omega-6 fatty acids also known as essential fatty acids (EFA). In a single-blinded randomized controlled trial design in Asia, 107 subjects with newly diagnosed impaired glucose metabolism and coronary heart disease supplemented with 1,800 mg/day of eicosapentaenoic acid experienced improved postprandial triglycerides, glycemia, insulin secretion ability, and endothelial function over a 6-month period.[35] The *n*-3 fatty acid supplementation for people with diabetes is shown to be beneficial for lipid lowering.[36] The PUFA consumption of Indians is well within the recommendations, however, among Indians linoleic acid-rich sunflower oil is the primary source of PUFA.[34] The study among Chennai urban adults showed that the use of sunflower oil was independently associated with increased risk for all the components of metabolic syndrome including central obesity and the risk was further intensified by the quantity of refined cereals consumed.[32]

Trans fatty acid

The trans fatty acid (TFA) intake in India is majorly from the use of hydrogenated vegetable oil like vanaspathi. Although the WHO recommends restricting the TFA intake to < 1% of total energy intake, a study in north India reflects the consumption of TFA of 1.11% among adolescents and 1.13% among young adults.[34] The CURES study assessed the fatty acid content of various commonly consumed foods to understand the fatty acid profile of the population and found that foods consumed as breakfast and dinner had the highest TFA content but the total intake of TFA among Chennai urban adults was within the recommended intake of < 1% calorie.[33]

"FAD Diets" and Diabetes

A diet that is extremely high in some components but lacks other components, becomes popular for some time but later its popularity fades is called a "FAD diet." FAD diets are often contrary to dietary recommendations and practices yet people are made to believe that they confer health benefits. These FADs are gaining popularity because they claim not only to prevent and manage NCDs well but they also promise to cure or complete reversal of diabetes and hypertension. The WHO only recognizes hyperglycemia reversal but clearly states the possibility of relapse if there is weight gain. For this purpose, the ADA clearly distinguishes between the terms "cure," "reversal," and "remission" and states that the term cure can only be applied to acute diseases such as infectious diseases and not for chronic diseases like diabetes. Discussing the term reversal, it states that medically the term can only mean that the person's health is restored such that he is free from disease. However, that is not the case in diabetes mellitus because there continues to exist a possibility for patients to develop diabetes again if there is weight gain. Therefore, the ADA permits the usage of the term remission and there can be three types of remission. (i) *Partial remission* is when HbA1C levels are at levels of prediabetes without the use of oral hypoglycemic drugs for one year. (ii) *Complete remission* is a term that means that the individual has achieved normal levels of HbA1C for a period of one year without the usage of oral hypoglycemic agents. Furthermore, to replace the term reversal, ADA

has approved the term (iii) *prolonged remission* to address individuals whose complete remission lasts longer than five years. The following are the diets that have been popularly used in achieving remission or to contribute to excessive and extreme weight loss among obese individuals thereby contributing to the improvement of lipid and glycemic parameters. It is important to understand that these diets have not been scientifically evaluated for their sustainability and are considered to be extreme in nature.[37-39]

Very low-calorie diet

Trials involving very low-calorie diets (VLCDs) almost a quarter of that of daily consumption began after the "twin cycle hypothesis" was proposed.

The twin cycle hypothesis

Prof. Taylor from Newcastle, UK postulated the "twin cycle hypothesis" after a group of Italian researchers published a study about attaining normal blood glucose levels post gastric bypass surgery in patients diagnosed with type 2 diabetes. The hypothesis presents the pathophysiology of diabetes as a combination of triglyceride accumulation in the liver and metabolic impairment of beta cells rather than a destruction of beta cells.

The starting point is the consumption of excess calories coupled with muscle insulin resistance precipitated by genetic and lifestyle factors. The conversion of excess calories into fat by de novo lipogenesis increases liver fat storage. Liver insulin sensitivity is largely dependent on the intrahepatocellular triglyceride (TG) content. The increase in hepatocellular TG induces resistance to the insulin suppression of hepatic glucose production. This leads to an increase in insulin secretion and a mild increase in plasma glucose levels. The TG in the liver is circulated as VLDL and is deposited in various organs including the islets of Langerhans of the pancreas thereby suppressing the beta cell activity and increasing postmeal responses to glucose.[40]

This hypothesis was proved true through the Counterpoint,[41] Counterbalance,[42] and DiRECT[43] studies that involved subjects with type 2 diabetes administered with a 600-kcal diet using liquid meal replacers and an additional 200 kcal contributed by the intake from nonstarchy vegetables. The Counterpoint study was the first to test the twin cycle hypothesis and the findings of the study at the end of the eighth week showed that HbA1C decreased from 7.4 ± 0.3% to 5.7 ± 0.1% and fasting plasma glucose levels decreased from 9.2 ± 0.4 to 5.9 ± 0.4 mmol/L. The average weight loss during the course of intervention was 15.3 ± 1.2 kg. In the Counterbalance study, the investigators attempted a stepped re-introduction of isocaloric diet over two weeks which was followed by a weight maintenance phase for six months and tested the durability of VLCD after normalization of food intake. The study reported that 40% of its population (responders) achieved remission after returning to isocaloric diet and after six months of weight-loss maintenance, 43% of the study population (responders) remained in remission. They were reported that the responders were participants with lower HbA1C values, lower fasting plasma glucose levels, and lesser duration of diabetes at baseline. The values at the beginning and end of the study were similar to that of the Counterpoint study[41] among the responders. The DiRECT[43] study followed the same protocol as the Counterbalance study but assessed the probability of remission at a much larger scale and for a period of one year with a primary objective of evaluating the possibility of remission at the primary care setting comparing between a standard diabetic diet and the VLCD. Among the participants of the intervention group, 68% of them achieved remission compared with 4% in the control group at the end of one year. In the intervention group, seven participants reported nine serious adverse effects compared with two adverse effects reported by two participants in the control group. Overall, at the end of the study remission of type 2 diabetes was probable at a primary care setting as evidenced by remission in nearly half of the participants.

Despite producing results of remission, the diet includes limitations that cannot be overlooked including sustainability, adverse effects such as hunger and appetite, short duration of diabetes reversal, and poor chances of reversibility in people with normal BMI. The monotony of the diet and its applicability in the Indian setting where food is integral to most celebrations make it difficult to scale this up to millions of people therefore with type 2 diabetes.

Severe carbohydrate restriction diets

The carbohydrate-restricted diets can be of two major types; *the low carbohydrate diet* which, according to ADA's definition is a diet including 130 g of carbohydrates per day or including < 26% of total calories from carbohydrates in a 2,000 kcal diet. The other is a *very low carbohydrate ketogenic diet* (VLCKD) restricts carbohydrates to less than 20–50 g/day or less than 10% of a 2,000 kcal diet. The basic physiology for remission in carbohydrate-restricted diets is very similar to that of the twin cycle hypothesis except for the fact that here carbohydrates are given more importance than calories. Volek and Phinney[44] have shown the effects of the diet on diabetes remission and describe the criteria and usage of the modern-day ketogenic diet or as they may call it; *well-formulated* ketogenic diet. As described, a *well-formulated* ketogenic diet is composed of 5%–10% carbohydrates (<20–50g/day), adequate protein (1–1.5g/kg/day), and fat until satiated. The hallmark of nutritional ketosis is blood ketone levels of 0.5–3 mg/dL. Ketones are also known to

cause epigenetic regulations that help in the body adapting to the alternate fuel source ketones. A ketogenic diet also induces lipolysis because there is an increase in glucagon due to increased fat ingestion and a decrease in insulin with reduced carbohydrate intake. Ketogenic dieters seem to be able to cope with the adherence to the diet as the diet suppresses appetite, control cravings, and improved effect. The study conducted by Volek and Phinney compared the VLCKD with a moderate carbohydrate diet noted that patients in the former diet had better glucose levels, weight loss, and lower levels of HbA1C than patients who consumed the latter diet. Even though an increase in LDL cholesterol was seen, it was noted that the particle size had only grown bigger and so was inversely correlated with the development of CVD.[45] However, more studies need to be done on this a long-term safety of such diets needs to be established.

The longest that nutritional ketoacidosis adherence and side effects have been observed is a 12-month study. Longer durations of this diet need to be studied for adherence and ill effects including the prevalence of uricemia, gout, and CVD. The diet's adherence also needs to be evaluated in Asian countries where carbohydrates are the staple diet. The diet is also hard to maintain among vegetarians.

Intermittent Fasting

Fasting has been a major behavior in various ethnic and religious cultures.[43] The most studied type of intermittent fasting (IF) occurs in the holy month of Ramadan.[46] The basic principle for IF is to take periodic breaks from eating.[47] IF or fasting-mimicking diets involve fasting for a short span lasting for 8 h or lesser and long periods of time with the fasting duration lasting anywhere between 2 and 21 days.[47] There are different types of IF and the most common of them includes fasting for a period of 24 h once a week and eating ad libitum throughout the remaining days of the week and this is known as prolonged fasting (PF) or intermittent calorie restriction (ICR). There is also time-restricted fasting (TRF) where the person eats only in 8-h period and fasts for the remaining 16 h every day. There is also alternate day fasting (ADF) where an individual alternates between fast and feast days and in some regimens, the individual is not allowed to consume any calories on the days of fasting. In IF there is a restriction on the calories that can be consumed. For example, someone who fasts 2 days a week is often at a 25% calorie deficit for the whole week and it is important to understand the physiologic responses to calorie restriction vis-a-vis the IF itself. In 1963, the fed-fast cycle was postulated and it comprises four phases namely the fed state, the postabsorptive or early fasting state, the fasting state, and the starvation or long-term fast state. In the fed state, which occurs 3 h after a meal, there is an increase in insulin, lipolysis is inhibited, glycogenesis occurs, and excess is stored as fat. In the postabsorptive stage, occurring 18 h postmeal, gluconeogenesis and glycogenolysis occur, and lipolysis is initiated therefore increasing fatty acid concentration. During the stage of fasting, which occurs 36 h after a meal, ketone bodies are formed and there is a shift in fuel utilization. There is muscle protein catabolism and lipolysis continues to increase. In the final stage called starvation, the ketone bodies continue to rise, BCAA utilization is stopped and lipolysis continues.[48]

A study published in the ESPEN,[44] discusses the improvement in lipid profile with or without weight loss pre- and post-IF and substantiates the statement with the following changes in lipid profile: Comparing the pre- and post-IF period, HDL levels can increase between 1 and 14 mg/dL, LDL levels decrease between 1 and 47 mg/dL, total cholesterol levels decrease between 5 and 88 mg/dL, and triglycerides levels decrease between 3 and 64 mg/dL.

IF had shown good results in decreasing the HbA1C levels and increasing insulin sensitivity but this was not a sustained effect as there was relapse after returning to a normal diet.[47] IF comes with its own list of setbacks including symptoms of dizziness and fatigue at the beginning of the diet and increased craving throughout the periods of fasting. IF in conjugation with antidiabetogenic drugs can cause fatal hypoglycemia in patients with type 1 and type 2 diabetes and the impact is even greater in the elderly. The diet is contraindicated for children, pregnant, and lactating women, and those engaged in heavy activity. The diet is also known to cause increased muscle loss.[47] Obviously, more studies are needed on these diets.

Paleolithic Diet or Paleo Diet

The paleo diet is based on the principle that ever as the stone age, there has not been much change in the configuration of the human genome and so to alleviate diseases of modern times, ancient eating practices must be employed to promote and restore good health. The paleo diet reached its peak in the year 2014 when consumers wanted to explore healthful eating practices and understand where their food was coming from. The diet includes lean meats, fish, fruits, vegetables, nuts, and seeds. Proponents of the diet emphasize choosing low-glycemic fruits and vegetables. Overall, the diet is high in protein, moderate in fat (mainly MUFA), low-moderate in carbohydrate, high in fiber, and low in sodium and refined sugars. The monounsaturated and polyunsaturated fats (come from marine fish, avocado, olive oil, and nuts and seeds).[49]

A pilot study was conducted to compare a standard diet with the paleo diet and this study found reductions in glycemic and lipid profile of the participants. There were lesser calories consumed by the participants who received the paleo diet even though no restriction was advised and these were positively correlated with a decrease in weight

and waist circumference as well. This study also reported good adherence to the paleo diet as established by the increased weight loss of 3.3 kg in the paleo dieters.[50] Chris Kresser a medical practitioner of functional medicine discusses the paleo diet and states that it is more effective than the low-fat diet propagated by the ADA.[51] However, the diet's setbacks include increased food expenditure (to buy meat), limitations in meal planning, and several nutritional deficiencies.[52]

Vegan Diet

A vegan diet is a strict vegetarian diet that avoids all animal foods and products and is completely plant based. Even though the diet was formulated for ethical purposes, it has been evaluated for its effects on various diseases including NCDs such as obesity and diabetes. Epidemiological studies have concluded that consumption of a diet high in meat can increase the risk for the development of diseases whereas high fiber consumption resulting from increased consumption of plant-based foods, fruits, and vegetables can help in the prevention and management of chronic diseases.[51]

A study conducted by the Korean Diabetes Association compared the consumption of a standard diabetic diet to a BR-based vegan diet and found a significant reduction in HbA1C in both groups of participants. However, the effect was higher among participants in the vegan group who had higher dietary adherence and the difference was ascribed to the consumption of low GI foods in the vegan dieters.[53] Another study in 2013 comparing the effects of low fat, and low GI vegan diet to a standard omnivore diet noted a fall in HbA1C levels in the vegan group by 1.23 points compared with 0.38 points in the standard diet group. Weight loss of 14.3 lb was observed in the vegan group compared with the 6.8 lb in those receiving a standard diet and reductions in LDL by 28 mg/dL were seen in the former and 10.7 mg/dL in the latter. Although a reduction in medications was not a goal in the study, 43% of participants were able to reduce their medications in the vegan group compared with a 23% reduction in the standard diet group.[54]

Although vegan diets confer these positive effects, the major challenge in the diet is to meet adequate micronutrient requirements. Vitamin B12 is the most critical nutrient missing in the vegan diet besides other nutrients such as amino acids, EFA, riboflavin, vitamin D, and minerals such as calcium, iron, iodine, zinc, and selenium.[55]

Conclusion

Through the years, several dietary recommendations have evolved and implementation of these recommendations have provided suitable outcomes. As novel dietary modifications continue to emerge, it is important for the healthcare fraternity to make unanimous decisions pertaining to treatment and the outcomes of the treatment. The VLCKD and LCD diets hold promise in the prognosis of type 2 diabetes. However, it should be understood that these studies have been primarily carried out in the western populations where the dependence on carbohydrates is relatively lower. Therefore, the suitability of these diets in the Indian setting is questionable. Nevertheless, as complex problems warrant complex solutions, these diets must be integrated and modified for the Indian setting addressing the possibility of remission in selected individuals. The clinical trials designed to achieve remission must not only address the burden of diabetes but must also take into account the undernutrition and hidden hunger prevailing in the country.

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Conflicts of interest

There are no conflicts of interest.

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