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Nutrition Therapy in Diabetes mellitus: a Retrospective Study

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Abstract

Diabetes is one of the biggest global public health problems with the estimated prevalence to increase from 425 million people in 2017 to 629 million by 2045, with linked health, social and economic costs. Type 2 diabetes is the fourth or fifth leading cause of death in most developed countries and there is growing evidence that it has reached epidemic proportions in many developing and newly industrialized countries. Since diet, physical activity and weight are modifiable factors and are also critical for slowing, or even reversing, this trend. Awareness about diabetes complications and consequent improvement in dietary knowledge, attitude and practices lead to better control of the disease. In order to improve the overall metabolism beyond calorie restriction and weight loss, it is crucial to integrate medical nutrition therapy into primary care of type 2 diabetes mellitus. This paper gives insight into need and different approaches of medical nutrition therapy (MNT) in type 2 diabetes. It outlines various approaches used till present based on studies and recommendations given. It is concluded that collaborative efforts from diabetologists, endocrinologists, and registered dieticians are required, since single approach to diabetes MNT does not exist. The diabetic diet must be nutritionally adequate for the patients' requirement and it should be tailor made for each individual patient based on age, sex, body weight and physical activity and taking into consideration, their lifestyle, socioeconomic factors, cultural background, and motivation too. Various studies concluded that evidence exists demonstrating that MNT can improve clinical outcomes while possibly decreasing the cost of managing diabetes.

Diabetes mellitus is defined as "a metabolic disorder characterized by hyperglycaemia resulting from either the deficiency in insulin secretion or the action of insulin." The poorly controlled DM can lead to damage various organs especially the eyes, kidneys, nerves and cardiovascular system.[1] Diabetes mellitus is a metabolic disorder characterized by the decreased ability or complete inability of the tissues to utilize carbohydrate,

accompanied by changes in the metabolism of fat, protein, water and electrolytes. Once regarded as a single disease entity, diabetes now seen as a heterogenous group of diseases, characterized by a state of chronic hyperglycemia, resulting from a diversity of etiologies, environmental and genetic acting jointly[22].

Diabetes is one of the biggest global public health problems with the estimated prevalence to increase from 425 million people in 2017 to 629 million by 2045, with linked health, social and economic costs.[13]. Type 2 diabetes is the fourth or fifth leading cause of death in most developed countries and there is growing evidence that it has reached epidemic proportions in many developing and newly industrialized countries[6]. Since diet, physical activity and weight are modifiable factors and are also critical for slowing, or even reversing , this trend. Diet is a leading contributor to morbidity and mortality worldwide according to the Global Burden of Disease Study carried out in 188 countries[14]. Nutrition and physical activity are important parts of a healthy life for a diabetic patient. Along with other benefits, following a healthy meal plan and being active can help keep blood glucose level, blood sugar, in target range. Improvement in the elevated HbA1c level can be achieved through diet management, thus the patients could be prevented from developing the diabetes complications. Awareness about diabetes complications and consequent improvement in dietary knowledge, attitude and practices lead to better control of the disease. In the light of above, medical nutrition therapy (MNT) plays an important role to reform the course of the adverse nutritional transition[8,11,16]. In order to improve the overall metabolism beyond calorie restriction and weight loss, it is crucial to integrate medical nutrition therapy into primary care of type 2 diabetes mellitus.

Approaches and Tools of Meal Planning :

*My Plate is a tool given by USDA that can be used to guide food choices. It helps control portion size. There is no need to count calories. A 9 inch plate is used, in which half of the plate covers non starchy vegetables, meat or other protein on one-fourth of the plate and grain and other starch on the last one-fourth of plate.

* *Carbohydrate Counting* involves keeping track of the amount of carbohydrates one eats and drink each day. Because carbohydrates turn into glucose in the body, they affect blood glucose level more than other foods. If insulin is taken, carb counting can help to know how much insulin to be taken.

*The term "medical nutrition therapy" was introduced in 1994 by the American Dietetic Association[3] to better articulate the nutrition therapy process. It is defined as the use of specific nutrition services to treat an illness, injury, or condition and involves two phases: 1) assessment of the nutritional status of the client and 2) treatment, which includes nutrition therapy, counselling, and the use of specialized nutrition supplements[3]. MNT for diabetes incorporates a process that, when implemented correctly, includes: 1) an *assessment* of the patient's nutrition and diabetes self-management knowledge and skills; 2) identification and negotiation of individually designed nutrition *goals*; 3) nutrition *intervention* involving a careful match of both a meal-planning approach and

educational materials to the patient's needs, with flexibility in mind to have the plan be implemented by the patient; and 4) *evaluation* of outcomes and ongoing monitoring. These four steps are necessary to assist patients in acquiring and maintaining the knowledge, skills, attitudes, behaviours, and commitment to successfully meet the challenges of daily diabetes self-management[26]. Leading authorities and professional organizations have concluded that proper nutrition therapy is an important part of the foundation for the treatment of diabetes. However, appropriate nutritional intervention, implementation, and ultimate compliance with the plan remain some of the most vexing problems in diabetes management for three major reasons: First, there are some differences in the dietary structure to consider, depending on the type of diabetes and medication the PWD is taking. Second, a plethora of dietary information is available from many sources to the PWD and healthcare provider. Nutritional science is constantly evolving, so that what may be considered true today may be outdated in the near future. Nutritional intervention may vary based on the type of diabetes; however, many of the basic dietary principles are similar for all PWD, prediabetes, metabolic syndrome or who are overweight or obese. Lastly, there is not perfect agreement among professionals as to the best nutritional therapy for individuals with diabetes, and ongoing scientific debate reported in the popular press may confuse PWD and health care providers[2]. Franz *et al.*[15]. completed a randomized, controlled trial in 179 individuals with type 2 diabetes, comparing the usual nutrition care consisting of only one visit with a more intensive nutrition intervention, which included at least three visits with a dietician. The results concluded that with more intensive nutrition intervention, changes in lifestyle can lead to significant improvements in glucose control. The fasting plasma glucose level decreased by 50–100 mg/dl and the HbA_{1c} dropped by 1–2%. The average duration of diabetes for all subjects was 4 years and the decrease in HbA_{1c} was 0.9% (from 8.3 to 7.4%). In the subgroup of subjects with a duration of diabetes <1 year, the decrease in HbA_{1c} was 1.9% (from 8.8 to 6.9%). By 6 weeks to 3 months, it was known if nutrition intervention had achieved target blood glucose goals; if it had not, the dietitian made recommendations for changes in medications.

**Time Restricted Eating* (TRE) It's not easy to count calories or figure out how much fat, CHO and proteins in every meal. That's why using TRE provides a new strategy for fighting obesity and metabolic diseases that affects millions of people worldwide. According to Dr. Satchin Pandan, Professor, Salk Institute and the author of Circadian Code, "Studies have shown that eating all calories within a consistent 10 hour window allows our body to rest and restore for 14 hours at night and fasting for the remaining hours in a day, protects from diseases such as type 2 diabetes. However, water is allowed during the fasting period. The science behind it is based on the concept of the circadian rhythm, which is the 24-hour cycle of living beings[25]. The scientists are currently conducting a clinical trial funded by the National Institute of Diabetes & Digestive & Kidney Diseases to examine the benefits of time restricted eating in a larger group of more than 100 participants with metabolic syndrome. The study includes additional measures that will help the researcher investigate changes in body composition and muscle function.

Table-1. Reviewed Eating Pattern AB Evert, 2013: Heising ETA 1993: Craig WJ 2009:

Type of eating pattern	Description
Mediterranean style	Includes abundant plant food (fruits, vegetables, breads, other forms of cereals, beans, nuts and seeds); minimally processed, seasonally fresh and locally grown foods; fresh fruits as the typical daily desert and concentrated sugars or honey consumed only for special occasions; olive oil as the principal source of dietary lipid; dairy products (mainly cheese and yoghurt) consumed in low to moderate amounts: fewer than 4 eggs/week; red meat consumed in low frequency and amounts, and wine consumption in low to moderate amounts generally with meals.
Vegetarian and vegan	The two most common ways of defining vegetarian diets in the research are vegan diets (diets devoid of all flesh foods and animal-derived products) and vegetarian diets (diets devoid of all flesh foods but including egg [ovo] and/or dairy [lacto] products). Features of a vegetarian-eating pattern that may reduce risk of chronic disease include lower intakes of saturated fat and cholesterol and higher intakes of fruits, vegetables, whole grains, nuts, soy products, fibre and phytochemicals.
Low fat	Emphasizes vegetables, fruits, starches (e.g breads,/crackers, pasta, whole grains, starchy vegetables), lean protein, and low-fat dairy products. Defined as total fat intake<30% of total energy intake and saturated fat intake <10%
Low carbohydrate	Focuses on eating foods higher in protein (meat, poultry, fish, shellfish, eggs, cheese, nuts and seeds), fats (oils, butter, olives, avocado), and vegetables low in carbohydrates (salad green, cucumbers, broccoli, summer squash). The amount of carbohydrate allowed varies with most plans allowing fruit (e.g., berries) and higher carbohydrate vegetables; however, sugar-containing foods and grain products such as pasta, rice and bread are generally avoided. There is no consistent definition of “low” carbohydrate. In research studies, definitions have ranged from very low-carbohydrate diet (21-70 g/day of carbohydrates) to moderately low-carbohydrate diet (30 to <40% of calories from carbohydrates.
DASH	Emphasizes fruits, vegetables and low fat dairy products, including whole grains, poultry, fish and nuts and is reduced in saturated fat, red meat, sweets and sugar-containing beverages. The most effective DASH diet was also reduced in sodium.

Table-2. Currently available recommendations for medical nutrition therapy for the management of diabetes mellitus[4,7,9,10,18,21,27]

Research Society for the Study of Diabetes in India (RSSDI)	American Diabetes Association (ADA)	Indian Council of Medical Research (ICMR)
Carbohydrates		
Recommended intake: 45-65% of total daily calories (minimum intake 130 gm/day)	No specified recommended intake	Recommended intake: 55-60% of total daily calories
High fiber diet: increased intake of soluble and insoluble fibers	High fiber and low glycemic index diet	Intake of fiber rich foods
Preferred sources: pulses, legumes, coarse grains, sprouted grams, unprocessed fruits and vegetables	Preferred sources: fruits, vegetables, whole grains, legumes and dairy products (milk and yoghurt)	Preferred sources: cereals, mixed coarse grains, whole grains (e.g ragi, oats, barley, jowar), whole pulses, whole fruits, salads and soyabeans, leafy vegetables, fenugreek seeds
Substitution of polished white rice with millets and brown rice		Restricted intake of all purpose flour (maida) based products
Proteins		
Recommended intake: 10-15% of total daily calories	Typically 15-20% of total energy in individuals without diabetic kidney disease Recommended daily allowance in individuals with T2DM and compromised renal function: of 0.8 g/kg body weight/day	Recommended intake; 10-15% of total daily calories
Preferred sources: not mentioned	Preferred sources: not mentioned	Preferred sources: vegetable sources, low fat milk and milk products, fish and lean meat

Fats		
Recommended calorie intake: no specified ideal intake	Recommended calorie intake: no specified ideal intake	Recommended calorie intake: 20-25% total daily calories
Restricted intake of saturated fats: <10% of total daily calories	Restricted intake of saturated fats: <10% of total daily calories	Restricted intake of saturated fats: <7% total daily calories
Minimal intake of trans fats	Minimal intake of trans fats	Minimal intake of trans fats (hydrogenated vegetable fats)
Restricted intake of dietary cholesterol: <300mg/day	Restricted intake of dietary cholesterol: <300mg/day	Restricted intake of dietary cholesterol: <300mg/day
Preferred sources of MUFA/ PUFA*: moderate intake of fish/seafood, chicken without skin and red meat as a source of PUFA (particularly in patients with established cardiovascular disease)	Preferred sources of MUFA/ PUFA: fatty fish, nuts and seeds	Preferred sources of MUFA/ PUFA: groundnut, sesame, cotton seed, rice bran or safflower along with soyabean, mustard, canola etc., as a preferred choices for edible oils containing MUFA and PUFA
Not recommended: sunflower oil • Mono-unsaturated fatty acid (MUFA) • Poly-unsaturated fatty acid (PUFA)		
Sugars and sweeteners		
Reduced intake of refined sugars	Reduced intake of HFCS and sucrose	Avoidance of sugar, honey, jaggery
Moderate intake of non-nutritive artificial sweeteners	Substitute nutritive sweeteners with non-nutritive sweeteners	Restricted use of artificial sweeteners and avoidance in pregnant/lactating women with diabetes
Avoid consumption of High Fructose Corn Syrup (HFCS)	Natural fructose/free fructose from fruits (3-4% of energy intake and not >12) is permissible	Avoidance of very sweet fruits and juices

Micronutrients and other dietary recommendations Inclusion of micronutrients (chromium, alpha-lipoic acid, magnesium and zinc) as adjunct to standard care (insufficient evidence available)	Not recommended	Not recommended
Restricted intake of dietary salt:< 5 g/day (further restriction in patients with diabetes and hypertension) Avoidance of alcohol consumption Cessation of tobacco use	Restricted sodium intake: <2300 mg/day Moderate alcohol consumption	Restricted intake of dietary salt: ≤ 6 gm/day Moderate of alcohol consumption Cessation of any form of tobacco use

The Three Major Components of Diet :

Carbohydrates: Normal regulation of blood glucose (post prandial and fasting) is the primary goal in the management of diabetes. Though many literatures recommend for low carbohydrate diet in diabetes. However, recently ADA in their 2019 position now state "research indicates that low carbohydrate eating plans may result in improved glycemia and have the potential to reduce anti hyperglycaemic medications for individual with type 2 diabetes." Further low carbohydrate diets are not recommended for pregnant and lactating women, those who have or are at risk for disordered eating and those with renal disease[12]. It is known that a high carbohydrate intake increases the requirement for insulin secretion in order to maintain glucose homeostasis[24]. Post prandial glucose and insulin responses are influenced by dietary fibre also. In addition to quality and quantity , different characteristics of carbohydrates in the diet needs to be taken care of. Whole grains have higher fibre content than refined ones. Foods with higher Amylose content are recommended as compared to Amylopectin. Raw and large particles are better than cooked and homogenised particles. Large size of starch particle is better than small particle size.[22] Since there are considerable differences in the physiological responses to different forms of carbohydrate, the term Glycemic Index (GI) was coined in 1981. GI is a measure of the post-prandial glucose response after carbohydrate consumption. (NP Steyn, 2004) Glycemic Index determines the quality of food. Kanika Malhotra, Senior Nutritionist, Health

Care at HOME (HCAH) agrees, "GI also depends on whether the food is eaten in isolation or with other foods. Consuming a food along with protein, fat or other CHO that have a lower GI effectively lowers its GI value. Other factors that might affect a food's GI include the ripeness of fruits (under-ripe fruits have a lower GI than ripe ones) and also how food is cooked. (food.ndtv.com).

Glycemic index does not take into account the effect of a typical amount of carbohydrate in a food portion on glycemia. In order to improve the reliability of predicting the glycemic response of a given diet, Salmeron et al have suggested the use of glycemic load. The glycemic load of a particular food is the product of the glycemic index of the food and the amount of carbohydrate in a serving. By summing the glycemic load contributed by individual foods, the overall glycemic load of a meal or the whole diet can be calculated[22].

Strong evidence exists that consuming high levels of fructose-containing beverages may have particularly adverse effects on selective deposition of ectopic and visceral fat, lipid metabolism, blood pressure, and insulin sensitivity compared with glucose-sweetened beverages[16].

Protein: Researches and literatures do not recommend high or low protein diet for diabetics. The recommendation regarding protein is similar to general population-10-2-% of total calorie. In individuals with type 2 diabetes, ingested protein appears to increase insulin response without increasing plasma glucose concentrations. But, in patients with renal insufficiency requires an individualized approach. (Alison B. Evert) A number of studies in healthy subjects and in persons with controlled type 2 diabetes have demonstrated that glucose from ingested protein does not appear in the general circulation, and therefore protein does not increase plasma glucose concentrations. Furthermore, the peak glucose response to carbohydrate alone is similar to that of carbohydrate and protein, suggesting that protein does not slow the absorption of carbohydrate.

Total Fat: 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. The primary dietary fat goal in persons with diabetes is to limit saturated fat and dietary cholesterol intake. Saturated fat is the principal dietary determinant of plasma LDL cholesterol. Furthermore, persons with diabetes appear to be more sensitive to dietary cholesterol than the general public. In metabolic study diets, in which energy intake and weight are held constant, diets low in saturated fat and high in carbohydrate or enriched with *cis*-monoun-saturated fatty acids (monounsaturated fat) lower plasma LDL cholesterol equivalently. Low-saturated fat (i.e., 10% of energy) high carbohydrate diets increase postprandial levels of plasma glucose, insulin, triglycerides and, in some studies, decrease plasma HDL cholesterol when compared in metabolic studies to isocaloric high monounsaturated fat diets. However, high-monounsaturated fat diets have not been shown to improve fasting plasma glucose or HbA_{1c} values. There is concern that when such high monounsaturated fat diets are

eaten ad libitum outside of a controlled setting, it may result in increased energy intake and weight gain. Therefore, both the metabolic profile and the need to lose weight will determine nutrition therapy recommendations. Furthermore, ethnic or cultural preferences may play a role in determining whether saturated fat is to be replaced with carbohydrate or monounsaturated fat.

Polyunsaturated fats have not been well studied in persons with diabetes. When compared with saturated fat, polyunsaturated fats appear to lower plasma total and LDL cholesterol, but not as well as monounsaturated fats.

N-3 polyunsaturated fatty acid supplements have been shown to lower plasma triglyceride levels in persons with type 2 diabetes. Although the accompanying rise in plasma LDL cholesterol is of concern, glucose metabolism is not likely to be adversely affected with their use. N-3 supplements may be most beneficial in the treatment of severe hypertriglyceridemia. While n-3 fatty acid studies in persons with diabetes have primarily used supplements, there is evidence from the general population that foods containing n-3 fatty acids have cardioprotective effects. Two to three servings of fish per week provide dietary n-3 polyunsaturated fat and can be recommended.

Major sources of *trans* fatty acids in the diet include products made from partially hydrogenated oils such as baked products (including crackers and other snack foods), cookies, doughnuts, breads, and products like fries or chicken fried in hydrogenated shortening. Animal sources, including dairy products, provide smaller amounts of *trans* fatty acids. The effect of *trans* fatty acids is similar to saturated fats in raising plasma LDL cholesterol. In addition, *trans* fatty acids lower plasma HDL cholesterol. Therefore, intake of *trans* fatty acids should be limited. Plant sterol and stanol esters block the intestinal absorption of dietary and biliary cholesterol. Plant sterols/stanols in amounts of <“2 g/day have been shown to lower total and LDL cholesterol**.** (ADA Position Statement). In order to achieve adequate glycemic control Medical Nutriton Therapy (MNT) is extremely important for diabetic and prediabetic patients.

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