NUTRITIONAL AND DIETARY STRATEGIES FOR TYPE 2 DIABETES MELLITUS WITH MICRO AND MACRO VASCULAR COMPLICATIONS – A REVIEW

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ABSTRACT:

Nutrition is crucial for both preventing and controlling type 2 diabetes mellitus (T2DM). This review analyzes the effects of macronutrients, and micronutrients on glycemic management and complications associated with diabetes. Diets high in whole grains, fruits, vegetables, and healthy fats, have been shown repeatedly to increase insulin sensitivity and lower risk for cardiovascular disease. Diets high in protein and low in carbohydrates have demonstrated benefits in the short term for managing weight and glycemic control, but research on long-term adherence and safety is still being conducted. Because of their functions in glucose metabolism and ability to reduce oxidative stress and inflammation associated with diabetes, micronutrients such as vitamin D, magnesium, and other antioxidant vitamins are also covered. The need for customized diet regimens based on patients' metabolic histories, habits, preferences, and concurrent medical conditions are highlighted by the fact that, despite improvement, individual reactions to dietary interventions differ greatly. In order to controlling glycemic levels, minimize complications, and enhance the standard of everyday life, this study emphasizes the significance of including nutritional counseling and education into diabetes management. Long-term research evaluating the impact of customized dietary strategies and their effects on development of diabetes should be the main focus of future studies.

KEYWORDS: Diabetes, Diet, Nutrition, Diet Therapy, Glycemic Control, Dietary Intervention

INTRODUCTION:

Diabetes Mellitus is a global significant health issue. Its prevalence which was 425 million in 2017 is expected to increase 629 million by the year 2045[1]. This disease is associated with serious complication which affects patient health, economy and quality of life. More than 50 % of diabetic population die of heart disease and stroke. It is also a major cause of Chronic Renal Disease which require dialysis or kidney transplantation for survival. Diabetic Retinopathy (DR) is an also a major cause of blindness due to prolonged poor glycemic control. Type 2 diabetic patients have also a higher risk of lower limb amputation that may be 25 times greater than those without diabetes [2]. One of the pillars of managing diabetes is following a proper diet [3]. Most diabetic guidelines recommend nutritional and physical

activity as first line measure followed by pharmacotherapy. Unfortunately, most physicians are not trained in nutritional therapy of diabetes and hence proper nutritional counselling to the patients has become difficult. In resource poor setting when the patient is diagnosed with type 2 diabetes, they are prescribed a list of medication and no proper dietary advice is given. Generally, patients are advised to increase the vegetable and fruit intake. But their cost is prohibitively mostly high. In addition, market foods labelled as for use of diabetic population also exist. But most of the products often being less healthy and expensive [4]. Hence in the present review article, some important basic principles were brought consensuses exist are presented.

MEDICAL NUTRITION THERAPY FOR TYPE 2 DIABETES MELLITUS:

The aim of Medical Nutrition Therapy for Type 2 Diabetes Mellitus (T2DM) is to control blood glucose, lipids and blood pressure so that the macrovascular and microvascular complications may be prevented or delayed. If the patients are supervised by a Clinical Dietician, a reduction of glycated haemoglobin (HbA1c) is seen [5]. The recommendations for nutritional and dietary management are as follows:

The main principle of the diabetic diet is moderate carbohydrate, adequate protein, healthy fat, high fibre and essential vitamins and minerals.

MACRONUTRIENTS:

1. **ENERGY:**
   Generally, a calorie intake of 1800 - 2000 kcal is suggested for diabetes patients with normal Body Weight by calculating 30 g / kg Body Weight. Calorie consumption for undernourished and obese diabetic patients can be as follows [6]:

Table 1 – SUGGESTED TOTAL CALORIE INTAKE (Kcal /Kg Body Weight/Day) FOR UNDERWEIGHT AND OVERWEIGHT DIABETIC PATIENTS

ACTIVITY	UNDERWEIGHT	OVERWEIGHT / OBESE PATIENTS
Sedentary Worker	40	20
Moderate Worker	40	25

2. **CARBOHYDRATE – GLYCEMIC MODULATORS:**
   Low glycemic index foods such as whole grains, fruits and legumes are preferred. Refined carbohydrates like Ultra High Processed (UHP) foods should be limited. Sucrose containing foods and sugary drinks should be limited. Low calorie or unsweetened beverages should be preferred [7].

3. **PROTEINS – BODY BUILDERS AND SUGAR STABILIZERS:**
   The protein intake of diabetes patients should be 15-20 % of total energy intake. Protein supplies the essential amino acids for tissue repair and they do not raise blood sugar as much as carbohydrates. Further the amino acids in protein also stimulate insulin secretion[6]. Generally, 1 g of protein per Kg Body Weight is adequate. However, in diabetic patients with nephropathy, it is advised that protein intake

should be restricted to 0.8 g / Kg Body Weight [8]. Studies have shown that restricting protein intake was associated with a slowing of decline of Glomerular Filtration Rate and also a significant reduction in HbA1c. Proteinuria can be reduced by using vegetarian diet and diets deriving protein from soy and other plant sources[9].

4. **FAT – ENERGY RESERVE AND HORMONE HELPERS:**

Dyslipidemia is a serious complication of diabetes. The primary goal in fat intake for diabetic patients is to limit saturated fat, and to increase poly and mono unsaturated fats. Saturated fat is the main dietary determinant of LDL cholesterol. Both poly unsaturated and mono unsaturated fat lower total cholesterol and LDL. But MUFA produces a profound effect. It is suggested that fat consumption should not be more than 35 % of the total kcal (energy) per day. It is also advised that less than 10% of energy intake should come from saturated fats. Trans fatty acids raise plasma LDL cholesterol. Additionally, they also lower HDL cholesterol. Hence intake of trans fatty acids should be avoided.

Regular fish intake of minimum 2 servings a week especially oily fish such as salmon, mackerel and trout is advised for cardiovascular protection in view of high MUFA content [10].

5. **FIBRE - BLOOD SUGAR BALANCER:**

Dietary fibres are the edible parts of the plants that are not digested by human body. It is advised that a total fibre around 30 g per day. There are two types of fibres – soluble and insoluble. It has been shown that the benefit is greatest for soluble fibres which are obtained from different plant sources – Beta glucan from oats and barley, mucilage from psyllium husk, pectin from apple, citrus fruits, pulses, aubergine and ladies finger. Soluble fibres have been shown to delay gastric emptying and absorption of glucose in the small intestine. By these mechanisms, post prandial hyperglycemia. Insoluble fibre has failed to show similar metabolic advantages like soluble fibre but they increase in stool bulking and helps in preventing constipation related to diabetic gastroparesis [11].

MICRONUTRIENTS - METABOLIC MODULATORS & ANTIOXIDANT DEFENDERS:

VITAMINS:

Vitamins are organic compounds required in limited amounts as vital nutrients. Vitamins cannot be synthesized in body and so should be obtained from diet with vitamin D, B 12 and K being an exception as it can be obtained on exposure to sunlight and from synthesis in gut. Vitamin A, C and E are antioxidants. Antioxidants help prevent the complications associated with diabetes. Oxidative stress and damage by free radicals can affect blood vessels and organs. It has been shown that the antioxidant effect of vitamin C, E and A can reduce this damage [12].

6. VITAMIN C – CELLULAR DEFENSE AGENTS:

It has been found that higher plasma vitamin C levels were associated with lower risk of diabetes. It was also observed that fruits and vegetables which are rich in vitamin C were also involved in reducing the risk of developing diabetes [13]. It was also found that a 50 % reduction in incidence of retinopathy with a high fruit and vitamin C intake [14]. It was proposed that diets rich in fruits can improve dietary antioxidants which in turn likely to reduce oxidative stress in diabetic population.

7. VITAMIN D – INSULIN SENSITIVITY MODULATOR:

Vitamin D is a fat – soluble vitamin, though it can be obtained through food, it is also produced in the body by the action of ultraviolet Beta rays from the sunlight on the skin. Many studies have shown that the association between type 2 diabetes and low serum vitamin D levels were strong [15]. In another study, people with type 2 diabetes were administered 50,000 IU oral vitamin D3 for eight weeks. There was significant reduction of fasting plasma glucose and insulin resistance at the end of the study [16]. Another study in older people has that 25(OH)D reduced type 2 diabetes by upto 55 % [17]. Hence it is suggested that vitamin D level should be estimated regularly and deficiency should be treated.

8. VITAMIN E - ANTIOXIDANT PROTECTOR:

It is also a fat - soluble vitamin and antioxidant which protects the integrity of membranes by inhibiting lipid peroxidation. Although evidence suggest that no beneficial effect of vitamin E intake in reducing blood glucose in people with type 2 diabetes, it may decrease HbA1c levels in people with poor glycemic control [18]. It has also been reported that high dose of vitamin E supplements more than 400 IU per day may increase mortality rate and should be avoided [19]. Thus, the supplementation of vitamin E is controversial at present.

9. VITAMIN B1 - THIAMINE:

Thiamine is an essential cofactor involved in metabolism of carbohydrates. In fact it was shown that blood thiamine levels were 75 % less than normal range in individuals with type 2 diabetes[20]. It was proposed that supplementation with thiamine may reverse early stage of nephropathy. When 300 mg of vitamin B1 was given daily for three months to diabetes patients with microalbuminuria, reduction in urinary albumin excretion was seen [21]. This has led to recommendation that high dose of thiamine could be used as a treatment for early stage of nephropathy. It was also noted that no serious adverse effects were observed with 300 mg supply of thiamine.

10. VITAMIN B3 - NIACIN:

Some studies have shown niacin can be used to lower cholesterol and triglycerides. It may also raise High – Density Lipoprotein. Its use is also associated with significantly decreased incidence of coronary stenosis progression and major cardiovascular events. However, niacin supplementation produced a modest increase in the risk of new – onset type diabetes. Hence there is hesistation in liberal utilization of niacin [22].

11. VITAMIN B 12 - METHYLCOBALAMAIN:

In type 2 diabetes patients, vitamin B 12 deficiency is found in higher incidence especially patients on metformin therapy as oral hypoglycemic agent [23, 24]. Vitamin B 12 deficiency produces neuropathy, anaemia and cognitive impairment. Deficiency of this vitamin can also be caused by following a diet which does not contain animal and dairy product. It might be due to lack of intrinsic factor which is required for the absorption of this vitamin. It is the only water- soluble vitamin that can be stored in liver for two to three years. It is preferable to measure vitamin B 12 levels periodically in elderly people under metformin therapy.

MINERALS:

Minerals are required at a very low concentration for maintaining normal growth and metabolism. They act as co – factors and co – enzymes for metabolism control and oxidative stress [25]. Some important minerals associated with type 2 diabetes are:

12. SELENIUM:

It is an essential component of enzymes for redox reactions such as glutathione peroxidase. It can act as insulin mimetic. However high selenium concentration may result in gluconeogenesis and increase fasting blood glucose level. Therefore, there are chances for risk of diabetes [26].

13. CHROMIUM – INSULIN POTENTIATOR:

Chromium plays an important role in metabolism of glucose. Most diabetes patients are not chromium deficient. Chromium supplementation may also reduce the requirement of insulin or oral hypoglycemic drugs. Chromium also prevents lean muscle loss, reduces cholesterol and triglycerides [6]. It has been shown that four months administration of chromium has decreased post prandial and fasting glucose levels [27].

14. MAGNESIUM- ENZYMATIC REGULATION:

Magnesium is considered as a mineral which reduces the risk of cardiovascular disease in type 2 diabetes patients. Low magnesium status is associated with hypertension, coronary artery calcification, stroke and ischemic heart disease. Magnesium deficiency was shown to be associated with diabetes risk whereas magnesium supplementation as shown to improve glycemic control in type 2 diabetes patient[28].

15. ZINC- ANTIOXIDANT AND INSULIN COFACTOR:

It is an important component of enzymes which regulates insulin sensitivity. It has been shown that in patients with type 2 diabetes, the plasma concentration of zinc is lower. Zinc supplementation has improved insulin sensitivity and glucose tolerance [29]. Zinc deficiency has been shown to reduce insulin secretion and increased insulin resistance. Zinc intake may also improve healing of venous ulcers in elderly diabetes patients.

16. VANADIUM:

Vanadium appears at very low concentrations in humans. It occurs in association with proteins such as transferrin, albumin and haemoglobin that are essential for human physiology. Vanadium is shown to have insulin – mimetic properties and may be used as an adjuvant in treatment of diabetes [30]. Intake of vanadium is 1 mg / kg per day in form of vanadyl sulfate for four weeks decreased glucose levels in type 2 diabetic patients. The probable mechanism underlying this might be through increasing GLUT translocation to plasma membrane [31].

CONCLUSION:

Managing diabetes effectively requires a multi – factored approach with diet and nutrition playing a major role. Optimal nutritional approach is to maintain body weight within normal range, providing adequate intake of macronutrients and micronutrients. Considerable progress has been made in formulating evidence based dietary guidelines. However, areas of uncertainty and controversy remains and further research are needed to make dietary and nutritional advice as practical one.

CONFLICT OF INTEREST:

The authors declare there is no conflict of interest.

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