

# Dietary Modifications used for the Treatment of Type II Diabetes in Adults



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## Abstract

Given the increasing prevalence of diabetes and obesity worldwide, lifestyle interventions must be made in order to improve health and decrease the risk for chronic disease. While nutritional intervention, physical exercise, weight management, and oral medications can all be used for glycemic control, no specific criteria for dietary modifications have been established in the treatment of type II diabetes mellitus (T2DM). Additionally, the limited generalizability of past studies has failed to assess these nutritional approaches from a social ecological standpoint. Consequently, by comparing the metabolic effects of a low carbohydrate, low fat, Mediterranean style, vegan, and vegetarian diet, it will be possible to determine the long-term efficacy of such nutritional interventions. Moreover, these dietary treatments can be used to control and prevent the onset of T2DM through intrapersonal and interpersonal level modifications. However, further emphasis must be placed on T2DM management in order to prevent microvascular and macrovascular complications.

**Keywords:** Diabetes Mellitus; Diet; Type 2 Diabetes; Weight management

**Abbreviations:** T2DM: Type II Diabetes Mellitus; ADA: American Diabetes Association; WHO: World Health Organization; HbA1c: Glycated Hemoglobin; MNT: Medical Nutrition Therapy; RD: Registered Dietician; GI: Glycemic Index

## Introduction

According to the American Diabetes Association (ADA), type II diabetes mellitus (T2DM) is a hyperglycemic, metabolic syndrome characterized by insulin resistance and relative insulin deficiency [1]. Although genetic and environmental factors are related to the development of T2DM, the largest contributor to this chronic disease can be attributed to a lack of physical activity and excess body weight [2]. In addition to causing many microvascular complications, T2DM is the leading cause of kidney failure, heart disease, and stroke in the United States [3]. By reducing the quality of life and imposing such a healthcare burden upon society, the perception of T2DM has changed from a medical issue to global epidemic within recent years.

As of 2030, it is predicted that diabetes mellitus will be the 7<sup>th</sup> leading cause of death and affect 366 million individuals worldwide [4]. While this statistic includes both type I and II diabetics, the incidence of type II diabetes comprises 90% of all cases as a result of major lifestyle changes associated with a worldwide demographic transition [5]. Currently, the adult prevalence of T2DM has reached 8.3% globally and contributed \$376 billion to healthcare expenditure as of 2010 [6]. While current trends stress the importance of chronic disease prevention, T2DM can also be treated effectively through healthy meal planning, exercise programs, excess weight loss, and oral medication [3].

Diabetes management has been used as an effective method for limiting the debilitating health complications of T2DM through improved blood glucose control [7]. While this may be accomplished at various levels within the social ecological framework, it is important to address intrapersonal and interpersonal factors that enable behavior modifications in diabetes management. One way in which this can be achieved is through lifestyle interventions that target behavioral modifications. Behavioral changes have been shown to ameliorate health pathways, support systems, dietary patterns, and attitudes towards physical activity [8]. In contrast to drug interventions, diet and lifestyle changes have proven to be more successful and cost-effective in reducing the incidence of type II diabetes [9].

The standards of medical care for diabetes have yet to establish an optimal macronutrient distribution for weight loss and T2DM treatment [1]. More specifically, the American Diabetes Association believes macronutrient distribution to be based upon individual assessment of current eating patterns, preferences, and metabolic goals [10]. The only nutritional management guidelines currently being recommended to the type II diabetic population collectively are to select nutrient-dense, high fiber foods over processed foods; avoid sugar-sweetened beverages; replace with foods high in unsaturated fats; choose lean protein and meat

alternatives, limit alcohol consumption and decrease sodium intake to 2,300mg/day [1]. While the efficacy of low carbohydrate, low fat, Mediterranean style, vegan, and vegetarian diets studies have been assessed, no clear approach is promoted by the ADA in T2DM treatment. As a result, it is important to assess current literature on the effectiveness of current dietary modifications for controlling and preventing the onset of T2DM.

### Dietary Modifications

#### Low carbohydrate diet

The American Diabetes Association (ADA) suggests that carbohydrate restrictive diets should limit consumption to no fewer than 150g/day because they are generally associated with increased dietary fat intake and risk for cardiovascular disease [11]. However, recent studies have demonstrated significant health benefits among T2DM patients. In particular, studies using carbohydrate restriction for diabetic management showed improvements in glycemic control and high-density lipoprotein levels over the course of 1 year [12].

Several categorizations are used to define different carbohydrate restrictive diets; these include a very-low carbohydrate diet as one that consumes 21-70g/day and a moderately low carbohydrate diet as one that consumes 30-40% of daily calories from carbohydrates [13]. A study conducted by Saslow et al. [14], compared the effects of a moderate carbohydrate, low fat, and calorie-restricted diet to very low carbohydrate diet among obese individuals with T2DM. Glycated hemoglobin (HbA1c) levels not only decreased more drastically among those on the low carbohydrate diet, but also allowed for greater weight loss and discontinued use of diabetes medications among participants [14]. Furthermore, similar studies have shown that lowering carbohydrate intake demonstrates the same health benefits as drug therapy and can be used as a substitution for medication over time [15].

The use of a low carbohydrate diet is justified by the biological mechanism in which carbohydrate intake promotes insulin secretion, thus stimulating a more rapid development of diabetes [16]. More specifically, carbohydrate breakdown into glucose serves as the main control for glycogen metabolism, lipolysis, and lipogenesis [13]. However, this dietary modification is to not be confused with the very carbohydrate-restrictive Atkins diet. Instead, a low carbohydrate diet should be implemented as to improve glycemic control, be equally effective in weight loss as low-fat diets, be used to substitute fats as markers for cardiovascular disease, decrease the damaging effects of metabolic syndrome, and not require weight loss for beneficial health outcomes [15]. Despite showing short-term weight loss combined with lowered HbA1c levels, it is important to recognize that the longevity of a low carbohydrate has yet to be established [17].

#### Low glycemic index diet

In contrast to a low carbohydrate diet, it has been shown that long-term dietary interventions supporting post-prandial glycemia can prevent complications of T2DM [18]. One dietary

adaptation demonstrating the use of this metabolic effect is the low glycemic index (GI) diet. The glycemic index (GI) is determined by the glucose response measured during a 2-hour period after consumption of 50g of tested carbohydrate, divided by the glucose response after consumption of 50g of carbohydrate from a control food [19]. Low-GI classification ( $GI \leq 70$ ) is therefore dependent upon type of carbohydrate, fat and protein content, acidity, physical properties, soluble factors, and several other factors [20]. When Jenkins et al. [21], tested the effects of legumes as a low-GI treatment for T2DM, this food-specific diet demonstrated lowered HbA1C, blood pressure, heart rate, and estimated absolute risk for coronary heart disease in a randomized, controlled clinical trial.

The basis for a low-GI diet relies upon slowing glucose release into the bloodstream as to control insulin production and minimize glucose fluctuations throughout the day [7]. This mechanism further supported by significantly lowered HbA1c levels, improved lipid profiles, and greater weight loss observed among individuals on low-GI as compared to high-GI diet after 4 weeks [7]. Consequently, it has been suggested that a low-GI diet, which stresses a high consumption of fruits, vegetables, whole grains, and low fat dairy products, can be used for long-term weight maintenance in comparison to control diets.

#### Mediterranean diet

Since the introduction of the Mediterranean diet by Ancel Keys in the 1960s, a diet involving high consumption of vegetables, legumes, grains, fruits, nuts, and olive oil combined with moderate consumption of fish and wine, and low consumption of processed meat and whole-fat dairy products yields numerous health benefits [22]. Although this dietary lifestyle was initially associated with lower rates of cardiovascular disease, it has been shown to improve glycemic control and insulin sensitivity among type II diabetics [23]. More specifically, the anti-inflammatory effects of the Mediterranean diet act to improve insulin sensitivity through decreased production of cytokines by adipose tissue in obesity [24]. This is evidenced by a 52% decrease in diabetes risk along with improved lipid profiles, such as lowered low-density lipoproteins and increased high-density lipoprotein levels [22].

A traditional Mediterranean food pattern can reduce the risk for T2DM development by up 83% and is inversely related to the manifestations of glucose homeostasis among high-risk patients and the elderly population [25]. Furthermore, when combined with low-carbohydrate intake, a diet high in mono-saturated fatty acids promotes a low glycemic diet may act to reverse health complications and prevent development of T2DM [23]. As a result, the protective health factors associated with Mediterranean diet should be established as an effective method for both weight control and T2DM management.

#### Plant based diets: vegetarian and vegan diets

According to the American Dietetic Association, vegetarian and vegan diets are both nutritionally adequate and may provide health benefits that can be used in the prevention and treatment of chronic disease [26]. Vegetarian diets are defined those that exclude meat, seafood, or any products containing those

constituents [26]. A vegan diet, on the other hand, is one which completely abstains from animal products, including meat, fish dairy, and eggs [26]. By incorporating more fruits and vegetables in an individual diet, it is possible to improve glycemic control through increased satiety from fiber intake in diabetes treatment [27].

Although studies have yet to assess the impact of vegetarian diets in the absence of weight loss, plant-based foods significantly reduce the risk of cardiovascular disease, which is a major health complication associated with T2DM [27]. It has been observed that vegetarians have lower low-density lipoprotein cholesterol levels, lower rates of hypertension, and T2DM than non-vegetarians [26]. While this may be attributed to lower BMI rates and other confounding variables, an incremental incidence of T2DM was evident among vegans, lacto-ovo vegetarians, pesco-vegetarians, semi-vegetarians, and non-vegetarians [28]. Moreover, vegan and lacto-ovo vegetarian diets were shown to reduce the risk for T2DM by almost a one-half as compared to non-vegetarian diets and can reduce the need for oral medications among individuals with T2DM [29]. Therefore, by promoting foods that reduce oxidative stress and chronic inflammation, plant-based diets can increase longevity and reduce the risk for chronic diseases and cancer [30].

When comparison was made between guidelines set forth by the American Diabetes Associations (ADA) and a vegan diet, greater reductions in fat, saturated fat, and cholesterol intake along were reported along with increased weight loss and HbA1C levels among the vegan group [29]. Furthermore, it was noted that a beneficial aspect of the vegan diet is that it does not require limited food portions, carbohydrate intake, or estimation of food and its constituents to elicit macronutrient changes [29].

### Medical nutritional therapy

Since dietary modification requires intrapersonal level changes, diabetes management should incorporate dietitian-led nutritional intervention. The current approach being advocated by the ADA is medical nutrition therapy (MNT). This method aims to achieve glycemic control, lower blood pressure, maintain body weight goals, delay T2DM complications, and address individual nutritional needs based upon personal preferences through professional or registered dietitian (RD) consultation [10]. MNT initially utilizes a nutritional assessment, laboratory testing, medications, and other information referred to by a primary care physician to assess dietary patterns [31]. From this information, it is then possible for the RD to make macronutrient recommendations as to improve glycemic control, weight loss, and decrease lipid levels among high-risk diabetics.

According to Huang, Hsu, Wang, and Shin, providing individuals with knowledge of how to control glycemic status has been demonstrated through dietary intervention [32]. Despite no significant impact on insulin sensitivity, improved dietary habits can be achieved through interpersonal level changes among patients with poorly controlled type II diabetes [32]. Although personal interventions are required for this specific treatment,

recent studies have demonstrated the positive effects associated with a variety of standardized medical nutritional therapies.

### Discussion

In order to successfully manage diabetic patients, it may be necessary to integrate education, medical nutritional therapy, physical activity, oral hypoglycemic agents, and insulin treatments [33]. Given the strong association between T2DM and obesity, glycemic control among patients is often achieved through alternation of habitual energy intake in relation to expenditure, macronutrient diet composition, and metabolic characteristics [16]. Although overall caloric expenditure should be monitored among high-risk patients, the quality of carbohydrates, proteins, and fats being consumed are also significant factors to consider T2DM management. Whether a dietitian-led intervention is utilized, or intrapersonal level changes are made, diabetic complications can be minimized using low carbohydrate, low GI, Mediterranean, or high protein diets [34]. Therefore, in combination with MNT, dietary modification should be used as a foundation for the treatment of type II diabetes.

When comparing the effectiveness of a low carbohydrate, low-GI, Mediterranean, and plant-based diets, MNT should first consider the level of risk for diabetic complications along with individual preference along. On the other hand, a low carbohydrate diet should mostly be used in favor of a low-fat diet due to the fact that it may improve high-density lipoprotein levels and lower triglyceride levels [35]. Among individuals with the highest risk of cardiovascular disease more aggressive methods, such as oral medications, may be needed in order to achieve appropriate glycemic control.

Although all dietary modifications showed improved glycemic control, lifestyle changes must be combined with MNT in order to achieve long-term effects. More specifically, sustained reduction in HbA1c levels can be used in replacement of oral hypoglycemic agents and insulin medications if dietary changes through MNT are achieved [36]. As long as it is possible to maintain HbA1c levels below 7%, a low-carbohydrate, low-GI, Mediterranean, or plant-based diet should be used in lifestyle interventions for long-term management of type II diabetes mellitus in adult populations.

### Conclusion

While T2DM prevention is a more effective method for reducing the burden of chronic disease, it may be necessary to establish dietary guidelines for patients who are unable to afford medications for glycemic control. Although behavioral lifestyle changes require appropriate knowledge and education, intrapersonal changes can be achieved through appropriate diet and exercise changes. Additionally, dietary interventions, such as a low carbohydrate, low-GI, Mediterranean, and plant-based diets, can all effectively be used for glycemic control and weight loss in T2DM patients. However due to current limitations, there is a greater need for studies to assess the long-term efficacy and outcomes of dietary modifications in the absence of weight loss in management of T2DM.

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