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Types of vegetarian dietary patterns and their impact on diabetes and its complications

Yuanyin Zheng[1]

[1] College of bioscience and biotechnology, Hunan Agricultural University, Hunan, 410128, China

Yuanyin_Z@stu.hunau.edu.cn

Abstract. Globally, diabetes is on the rise year by year, with type 2 diabetes accounting for a larger proportion. The choice of dietary pattern has a very significant part in the prevention and control of diabetes, especially for type 2 diabetics. Vegetarian and plant-based dietary patterns have received very wide attention in recent years. Studies have indicated that vegetarian diets can help people with obesity and body weight loss, and that vegetarians are much less likely to develop diabetes than omnivores, making them a very popular and widely recommended diet in recent years. Vegetarian or plant-based diets can lower the chance of developing diabetes and control its progression. Different types of vegetarian diets have different effects and there are some differences in how they affect diabetes, but all can help in some way. By comparing recent studies, a vegetarian diet can help treat and improve diabetes and its complications in several ways: cardiovascular disease, gut microbiota, kidney, vision, blood sugar, and inflammation.

Keywords: Vegetarian, Diabetes, Dietary Patterns.

1. Introduction

One of the four main chronic diseases that are not contagious and one of the top 10 killers globally is diabetes, a dangerous chronic illness. According to information made public by the International Diabetes Federation, there would be 537 million diabetics globally in 2021, an increase of around 16% over the previous year. The number of persons who have diabetes is increasing yearly. Deaths from diabetes and its complications account for about 12.2% of all deaths. Of all diabetes types, type 2 diabetes accounts for a relatively large proportion. Diabetes has thus become a greater health concern. Vegetarian or plant-based diets have been a hot topic in recent years and are widely considered to be a healthy way of life. The number of persons who have diabetes is increasing yearly, and this is a rising trend worldwide. A vegetarian diet may help lower the chance of developing diabetes, according to several research, and there are also some studies that show that a strict vegetarian diet has some risks for people with diabetes. In many studies, it has been shown that type 2 diabetes can be improved to a large extent by diet. Among many dietary patterns, the more common ones are the Western diet, the Mediterranean diet, and vegetarian eating (including lacto-vegetarian, intermittent vegetarian, and vegan). Some studies have shown that vegetarian diets can largely decrease the incidence of diabetes and improve blood glucose and complications, etc. in diabetic patients compared to omnivorous diets. This paper will discuss which vegetarian diets are more beneficial for people with diabetes and

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vegetarian diets' impact on diabetes and its complications.

2. Diabetes

A prevalent type of chronic metabolic disorder is diabetes mellitus. The two types of diabetes that are most common are type 1 and type 2. One in ten adults (20 to 79 years old) will have diabetes worldwide in 2021, according to data, and that number is projected to augment to 643 million by 2030. In 2021, it is anticipated that 6.7 million adults aged 20 to 79 will die from diabetes or its complications. This represents 12.2% of all fatalities in this age range, and roughly one-third of diabetes deaths occur in those under the age of 60 (TABLE 1).

Table 1. Diabetes around the world(2000-2045).

	2000	2011	2021	2030	2045
Estimate diabetes (20-79)					
People with Diabetes, in 1000S	151,000.0	366,000.0	536,600.0	642,800.0	783,700.0
Comparative diabetes prevalence, corrected for SGE, %	4.6	8.5	9.8	10.8	11.2
Undiagnosed diabetics, in 1,000S	\	183,000.0	\	\	\
Percentage of persons with diabetes who are undiagnosed, %	\	50.0	44.7	\	\
Estimates of impaired glucose tolerance (20-79)					
People who have IGT, in 1,000S	\	280,000.0	541.0	622.7	730.3
IGT relative prevalence adjusted for age, %	\	6.5	10.2	10.8	11.2
IFG estimation with impaired fasting glucose (20-79)					
People who have IFG, in 1,000S	\	\	319.0	369.7	440.8
IFG relative prevalence adjusted by age, %	\	\	5.7	6.0	6.3

2.1. Type 1 Diabetes

Insulin-dependent diabetes mellitus (IDDM), often known as type 1 diabetes, is a congenital condition brought on by the body's inability to produce enough or any insulin at all. [2] In the range of 5–10% of those with diabetes, those with type 1 diabetes. Diabetes type 1 is an autoimmune condition with no known origin that can only be managed with insulin injections. There is no cure.

2.2. Type 2 Diabetes

NIDDM, another acronym for type 2 diabetes, stands for non-insulin-dependent diabetes mellitus. which is due to cells that do not respond, are not sensitive or do not respond properly to insulin. There is nothing inherently wrong with the pancreas, and the cause of the disease is mainly overweight or lack of exercise. Type 2 diabetes affects 90–95% of persons with the disease. According to several research, losing weight through diet and exercise can minimize the chance of developing type 2 diabetes. Diabetes has become one of the diseases of civilization in the developed world due to the greater consumption of refined diets and foods high in trans fats, and the number of patients is on the rise each year with a trend toward younger age.

2.3. Gestational Diabetes

Gestational diabetes is also a common type of diabetes in pregnant women who do not have a history

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of diabetes but have higher than normal blood sugar levels during pregnancy. Gestational diabetes is a complication that can lead to fetal developmental malformations, neonatal hypoglycemia, and other health problems that may also make the baby more likely to become obese during childhood or adolescence and increase the risk of type 2 diabetes when it grows up. After the baby is born, gestational diabetes always cures on its own, but it can raise the mother's future type 2 diabetes risk.

3. Vegetarian diets patterns

Vegetarian diets have become increasingly popular in recent years. More and more people are choosing vegetarian diets, and it is estimated that there are 1.5 billion vegetarians worldwide. The percentage of vegetarians worldwide is estimated to be 22% based on the most recent surveys. The reasons for people to choose a vegetarian diet are mainly personal and environmental. Some religious beliefs can influence people's choice of dietary patterns, for example, India has the highest percentage of vegetarians in the population this is related to the religious culture of most Indians. A vegetarian diet can also be a good way to help people reduce the risk of obesity and some chronic diseases. From an environmental perspective, a vegetarian diet can reduce the negative impact on soil, water and air compared to a meat-based diet. There are many types of vegetarianism, depending on which foods are not eaten. It can be roughly divided into vegan, lacto-ovo vegetarian, lacto-vegetarian, ovo-vegetarian, pescatarian, pollotarian and flexitarian.

4. Effect of different types of vegetarian diets on diabetes

The vegan diet is arguably the most strictly vegetarian. Vegan would not eat any meat, eggs, or dairy products, and they do not eat honey or use any animal by-products such as gelatin, leather, etc. According to the United Nations, there will be roughly 79 million vegans in the world in 2021. Study shows vegan diet has lowest incidence of diabetes, only 2.9% By reducing animal food intake, BMI and thus diabetes risk can be lowered [1].For diabetics, carbohydrates need to be controlled and it is recommended to choose carbohydrates with a low glycemic index. The high fiber content is good for blood glucose control but not good for digestion, and it is easy to consume too much, which requires attention. However, for children with diabetes, a vegan diet may affect growth and development because a vegan diet tends to be deficient in vitamin B12, vitamin D, DHA, etc. So, it needs to be strictly monitored for timely supplementation of the deficient elements [2]. In a lacto-vegetarian diet, dairy products like milk, yogurt, and cheese are permitted but no meat, poultry, fish, or eggs are allowed. The prevalence of lacto-vegetarian diabetes is about 3.2%. Lacto-vegetarians have a higher incidence of diabetes than vegans. However, dairy products are rich in calcium, and many are rich in vitamin D, which ensures healthy teeth and bones, which is important especially for children and the elderly. Dairy products such as yogurt and cheese are also a source of probiotics, which can be very beneficial for intestinal health. Ovo- and lacto-ovo vegetarians refrain from eating red, white, or salmon; lacto-ovo vegetarians, however, are permitted to eat dairy products, eggs, and other items produced from eggs. Ovo-vegetarians may consume egg products. Technically speaking, Pescatarians are not considered vegetarian in the traditional sense. They also consume animal protein but only fish and seafood excluding red meat and white meat. This diet is regarded as flexitarian or semi-vegetarian. The incidence of diabetes is also higher compared to other vegetarian types at about 6.1% [3]. However, a related survey showed that there is a high incidence of type 2 diabetes in South Asian vegetarians(including vegans, lacto-vegetarians, lacto-ovo vegetarians) in the UK [4]. And a vegetarian diet high in free sugars and refined carbohydrates and less physical activity may increase the risk of diabetes. Therefore, lowering meat intake does not necessarily reduce the risk of diabetes. Instead of meals made from highly refined flours and sugars, a vegetarian diet that lowers the risk of diabetes should be high in whole grain cereals, nuts, fruits, and vegetables.

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5. Mechanism of the diabetic diet effects of vegetarianism and its complications

5.1. Lowering Blood Sugar

Some studies have shown that vegetarian or plant-based diets can lower glycosylated hemoglobin, which is a measure of the average blood glucose level of diabetics over the past three months, and can be a good predictor of the future development of diabetes compared to fasting blood glucose levels [5]. Plant-based or vegetarian diets control blood glucose by reducing body weight, reducing energy intake, reducing fat and protein, increasing fiber, and increasing carbohydrates. Increased body fat is detrimental to insulin sensitivity, and high fat intake is associated with insulin resistance. A vegetarian diet can reduce fat intake by 10%, lowering body weight while improving insulin sensitivity to control blood sugar and lower glycated hemoglobin. Plant-based diets or vegetarian diets with high fiber intake are also beneficial for blood glucose control. According to studies, by slowing the intestinal absorption of glucose, dietary fiber can reduce the glycemic index of carbohydrates [6]. Consuming fiber helps the body produce short-chain fatty acids that help regulate the intestinal system and help control blood sugar levels. Therefore, a plant-based diet or a vegetarian diet can be a good way to decrease the risk of type 2 diabetes [6].

5.2. Anti-Inflammatory Effects in Plants

If diabetes is not properly controlled, it may cause severe metabolic inflammation. Inflammation may cause damage to blood vessels and tissues. The hyperglycemia and hyperlipidemia in diabetes are all likely to cause chronic inflammation, which may cause many complications. Some natural chemicals contained in plants can act as blood sugar reducers and anti-inflammatory agents, such as alkaloids, styrax and flavonoids [7]. Not only can these phytochemicals play an anti-inflammatory role in the treatment of diabetes, but the natural chemicals in plants have fewer side effects than existing drugs. However, natural chemicals from plants do not fully exert their anti-diabetic effects in vivo because they do not achieve the same biological activity as in vitro [7]. Therefore, further experiments and studies are needed on the use of anti-inflammatory chemicals from plants as a treatment for diabetes.

5.3. Lowered Risk of Cardiovascular Disease

According to WHO, the main cause of death worldwide is heart disease., which is the highest-ranking number one among non-communicable diseases. One of the top 10 killers in the world is diabetes. Cardiovascular disease is more common in diabetics than in the general population. Cardiovascular disease is also one of the common complications of diabetes. A vegetarian or plant-based diet is well known to reduce body fat percentage and obesity compared to an omnivorous diet, which helps reduce the risk of cardiovascular disease. Vegetarians have decreases in mortality for illness of the cerebral blood vessels and ischemic heart disease than non-vegetarians [8]. Vegetarians have lower cholesterol intake and lower lipoprotein intake relative to omnivores, both of which are associated with cardiovascular disease risk. According to research studies, vegetarians patients are almost half as likely to have high blood pressure than omnivorous [8].This is because animal proteins have an increased risk of hypertension, while plant-based proteins are beneficial in lowering blood pressure [9].

5.4. Plant-Based Diet Affects Diabetic Gut Microbiota

Studies have shown that some complications caused by diabetes are related to the gut microbiota. Plant-based diets can have a beneficial effect on the gut microbiome [10, 11]. Type 2 diabetes is a metabolic disease, and the gut microbiota's composition has been shown to be associated with diabetes through rodent models. The gut microbiota of disease-prone animals is significantly different from that of healthy animals. The body weight and BMI may be affected by the varied gut microbiota composition, which may also have an effect on metabolism and fat accumulation. Obesity and high-fat diets adversely affect the control of type 2 diabetes and also have an effect on the gut microbiota's composition [12]. For example, it can cause a decrease in bifidobacteria levels [12]. Some studies have

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shown that obese diabetics can temporarily improve insulin sensitivity by transplanting gut microbiota from lean healthy individuals [13]. Vegetarian dieters had lower levels of bacteria in their stools compared to omnivores [14]. A plant-based diet increases the diversity of the intestinal flora. Plant-based diets in general contain high amounts of fiber and polyphenols, and a high fiber intake can increase lactic acid bacteria and short-chain fatty acids in the gut, both of which are beneficial to intestinal health and also protect the integrity of the intestinal epithelium. Polyphenols can increase lactic acid bacteria and bifidobacterium which are good for anti-inflammatory effects and cardiovascular protection. Gut microbiota seems to be associated with BMI, obesity, and diabetes, and it may be possible to enhance type 2 diabetes management by altering the gut microbiota in the future (FIGURE 1) [15].

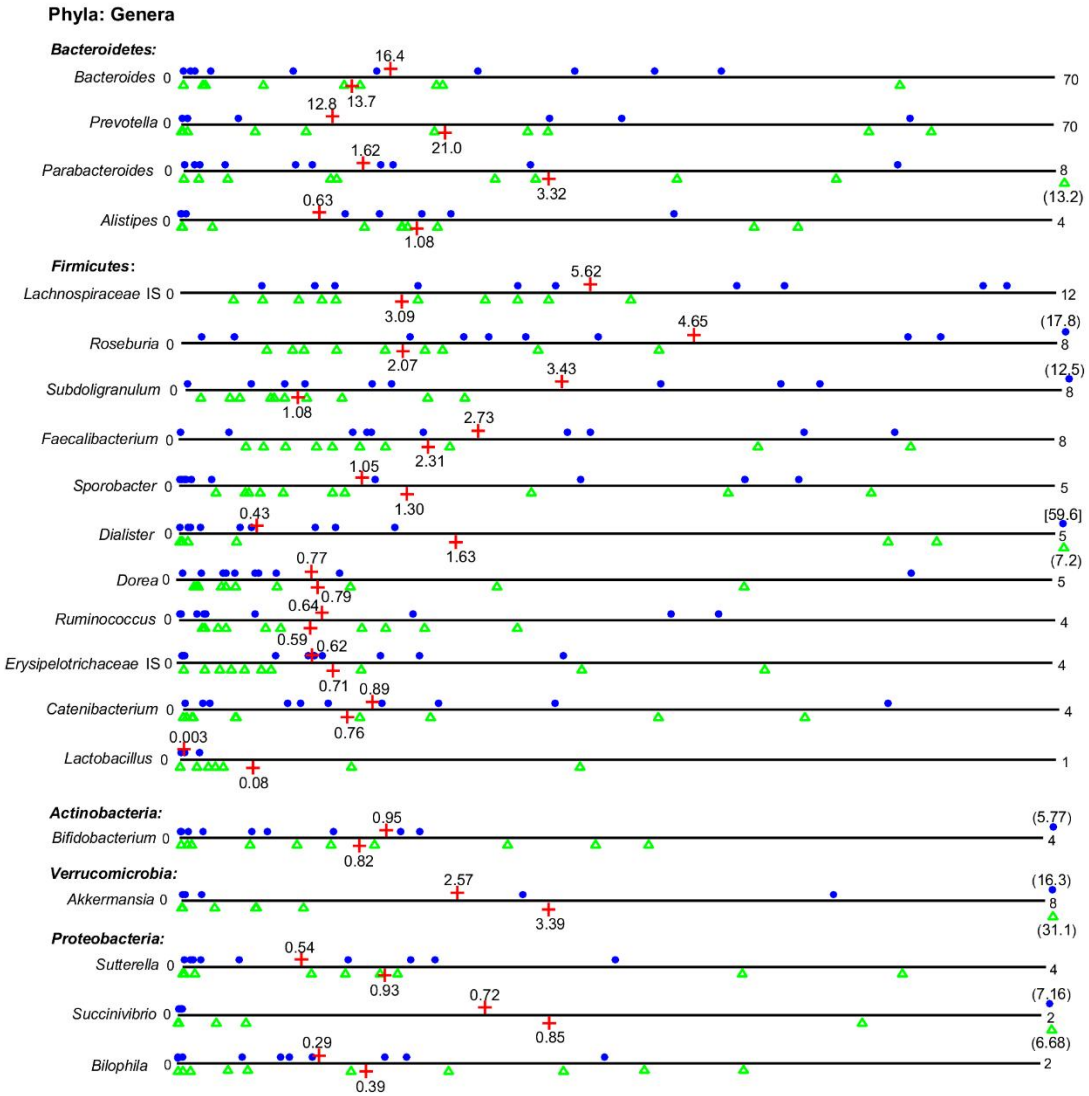

Figure 1. Gut microbiota in diabetic and non-diabetic patients. Green triangles (N=10) represent the abundance (%) of bacterial genera in the stool of adults with type 2 diabetes and blue dots (N=10) represent the abundance (%) of bacterial genera in the stool of non-diabetic adults. Red crosses and numbers indicate mean values. Values in parentheses are excess values [15].

5.5. Effect of Plant-Based Diet on Kidney Disease in Diabetic

Chronic kidney disease is one of the common chronic complications in diabetic patients. It is more

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common for diabetic patients to have renal dysfunctional disease. Type 1 and type 2 diabetes are two of the main metabolic factors that lead to chronic renal disease. Chronic kidney disease may exacerbate diabetes by decreasing insulin sensitivity, and hyperglycemia can exacerbate chronic kidney disease by increasing glomerular filtration. Limiting protein intake is one of the means to improve chronic kidney disease. Therefore, it is more recommended that patients adopt a Mediterranean diet or a plant-based diet. According to studies, vegetarians have a lower danger of chronic kidney disease compared to omnivores, and both lacto-vegetarian and vegan diets reduce the chances of developing chronic kidney disease [16]. Plant proteins are less stressful to kidney filtration than animal proteins. Replacing animal protein with plant protein may reduce excessive kidney filtration, proteinuria, and lower kidney failure [17]. In conclusion, it is possible to reduce the risk of diabetic nephropathy or improve diabetic nephropathy by reducing kidney load with a plant-based diet.

5.6. Diabetic Visual Disease

Eye disease is one of the possible complications of diabetes, which may range from affecting vision to severe blindness. Retinopathy is a microvascular condition that can affect persons who has type 1 or type 2 diabetes and is brought on by damage to the retina's blood vessels. The higher the blood sugar and the longer you have diabetes, the greater the chance of developing the disease. According to research studies, preventing the onset of diabetic retinopathy can be achieved with a Mediterranean diet that includes enough of fruits, vegetables, and fish [18]. A strict vegetarian diet may also lead to eye diseases such as optic nerve disease, especially in strict vegetarians who do not take vitamin supplements, which may be related to vitamin B12 and B1 deficiency [19]. According to studies, for type 2 diabetes individuals who are older or in their middle years, daily consumption of not less than five hundred mg of long-chain omega-3 polyunsaturated fatty acids is beneficial in reducing the risk of retinopathy. Therefore, it is useful and beneficial for diabetic patients, especially vegetarians, to supplement with essential vitamins and polyunsaturated long-chain omega-3 fatty acids [20].

6. Conclusion

This paper concludes that all types of vegetarian and plant-based diets have a positive effect on diabetes to some extent, except for strict vegetarian or vegan diets which can be risky for individual diabetics in terms of nutritional deficiencies, especially in older diabetics and adolescents. So, for young or older diabetics it is more recommended to have a lacto-vegetarian ovo-lacto-vegetarian diet or fish-vegetarian diet etc. If the patient insists on a strict vegetarian or vegan diet pattern, it is important to pay attention to whether the body is deficient in some nutrients, and if it is deficient, it needs to be supplemented with nutritional supplements in time to avoid adverse health effects. Vegetarian or plant-based diets can improve the situation of diabetics in many ways. Vegetarian and plant-based diets can be very helpful in lowering blood glucose, improving insulin sensitivity, and complications such as cardiovascular disease, intestinal health, kidney disease, and anti-inflammatory conditions. However, it is worth mentioning that a vegetarian diet can improve diabetes and decrease the risk of diabetes based on a healthy vegetarian dietary pattern, such as the intake of whole grains, nuts and legumes containing unsaturated fatty acids, vegetables, and fruits, rather than refined grains and ultra-processed vegetarian types. Future studies may be able to further investigate the impact and effect of vegetarian eating habits on the incidence and treatment of diabetes in different countries or in different ethnic groups in different regions.

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