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Eating a healthy diet with high protein and fibre and few carbs can help prevent T2DM

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Abstract
Today, worldwide Type 2 Diabetes Mellitus (T2DM) is rapidly increasing. Particularly in India, T2DM increasing day by day due to consumption of high calories foods and sedentary lifestyle are serious issues. It is identified by insulin resistance, deficiency of insulin secretion, and purposeful hyperglycemia, which can have catastrophic outcomes if left unchecked. One of the most crucial therapeutic measures against the development of T2DM is dietary intervention, which remarkably lowers the risk of the disease and delays its continuation. However, a protein-rich, fibre-based, low-carbohydrate diet has gained to preventive its potential activity. Not only does a high protein-rich, but fibre-based, low-carbohydrate food reduce blood sugar level, it increase glucose metabolism by helping maintain lean muscle mass and improving insulin sensitivity. Similarly, by slowing stomach emptying and glocose absorption, a high-fiber rich diet— specially one that is high in soluble content—improves postprandial glucose responses and general metabolic health. On the other hand, specially refined and high-GI carbohydrates contain Low carbohydrates, which decreases glycaemic load. This low-carb approach food improves glycaemic management and lowers the likelihood of obesity, a major risk factor for T2DM. Lifestyle modification, such as daily exercise, enough sleep, and reducing stress, might enhance preventive effects in addition to food adjustments.
However, there are still certain issues with ethnic eating customs, following a regimen, and guaranteeing the right nutritional balance, all of which require careful planning and instruction.
A nutritious diet rich in carbohydrates, fibre, and protein can prevent T2DM and improve the general health of diabetic patient.

Keywords: T2DM, insulin resistance, high-protein diet, high-fiber diet, low-carbohydrate diet, hyperglycemia, dietary fiber, glycemic control, obesity

Introduction
Type 2 diabetes mellitus (T2DM) is a chronic, non-communicable metabolic disease features sustained hyperglycemia due to insulin resistance. It has become a major global public health problem because of its rapidly increasing incidence and associated sequelae such as retinopathy, neuropathy, nephropathy, and cardiovascular diseases. Diabetes is one of the leading causes of premature death globally and its prevalence continues to rise, particularly in low- and middle-income countries such as India, according to the World Health Organization. The International Diabetes Federation (IDF) also found that the number of adults diagnosed with diabetes is undoubtedly increasing, and highlights a particularly alarming situation in developing countries such as India, which continues to be rife with urbanization, sedentary lifestyle and dietary habits [1, 2].
T2DM is a complex aetiology involving environment and genetics. Diet is the single most important modifiable risk factor for development and prevention of the disease. Over time, high processed, added sugar and refined carb diets rapidly increase blood glucose levels causing insulin resistance. These eating patterns are often associated with obesity, specifically central obesity that exacerbates metabolic dysfunction and increases the likelihood of type 2 diabetes [3, 4].
In the past few years, dietary approaches that focus on the timing and quality of macronutrients rather than solely calorie restriction have been well received. High-protein, high-fiber, low-carbohydrate diets have shown incredible promise in the prevention of the clinical onset of type 2 diabetes. High-protein diets are known to enhance insulin sensitivity, decrease overall energy intake while increasing satiety—effects that can be attributed in part to the preservation of lean body mass. Protein retains less impact on postprandial blood glucose levels compared to carbs. Dietary fiber, and particularly soluble fibers, are key elements for glycaemic control, because it delays the gastric emptying process and reduces glucose absorption rate in intestinal tract. Furthermore, fibre maintains a healthy microbiome within the gut, previously associated with improved metabolic outcomes. According to Joanne Slavin, 2013, a higher intake of fiber is assosiated with reduced risk of metabolic conditions like type 2 diabetes. On the other hand, reducing carbohydrates — particularly processed and high-GI (glycaemic index) carbohydrates — lowers insulin demand and glycaemic load. For mitigating T2D and supporting long-term metabolic health, a higher protein, higher fibre lower carbohydrate diet coupled with healthy lifestyle changes is generally recommended [3-5]

Pathophysiology of T2DM
1. Insulin Resistance
Refractory hyperglycemia in T2DM patients is primarily due to insulin resistance, which is characterized by a decreased responsiveness of peripheral tissues to the metabolic effects of insulin, as illustrated in Figure 1. It primarily affects adipose tissue, liver and skeletal muscle leading to impaired glucose homeostasis. Skeletal muscle insulin resistance leads to impaired GLUT4 translocation to

the membrane of the cell and decreased glucose uptake. It promotes liver gluconeogenesis and glycogenolysis even when blood glucose levels are elevated, and it reduces hepatic utilization of glucose. Insulin resistance leads to increased lipolysis in adipose tissue, resulting in elevated levels of free fatty acids circulating in the blood. Also high levels of free fatty acids exacerbates insulin resistance by disrupting the normal function of signalling pathways regulating insulin activity as well as promoting lipids accumulation in non-adipose tissues. This illness is also aggravated by metabolic disorders such as oxidative stress and inflammation. These adaptations play a key role in T2DM hyperglycemia initiation and progression [6, 7].

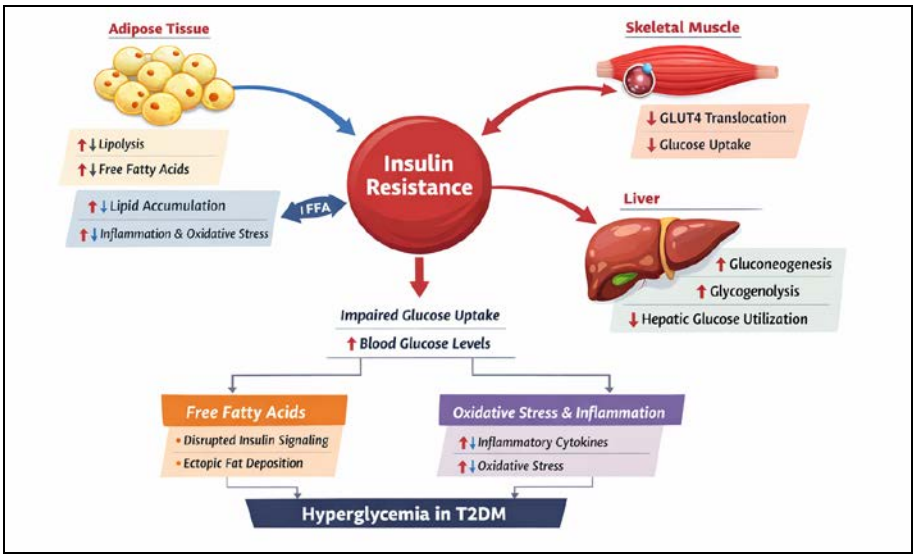

Fig 1: Mechanisms of Insulin Resistance Leading to Hyperglycemia in T2DM

2. β-Cell Dysfunction

In the pathogenesis of Type 2 Diabetes Mellitus, one of the major factors includes β-cell dysfunction. Pancreatic β-cells produce more insulin to keep the blood glucose stable in the first stages of insulin resistance. In contrast, chronic metabolic stress leads to gradual decline in β-cell mass and function. Glucotoxicity due to chronic hyperglycemia inhibits insulin gene expression and secretion. Simultaneously, elevated-free fatty acid levels in the blood lead to lipotoxicity that interferes with β-cell metabolism and causes intracellular lipid accumulation. These factors, combined with chronic oxidative stress, lead to damage of DNA and mitochondria which contributes to β-cell apoptosis [6, 7].

In addition, β-cell malfunction is aggravated by the presence of inflammatory mediators and endoplasmic reticulum (ER) stress. As a result, the pancreas cannot secrete sufficient insulin to counteract insulin resistance. This continued decline in insulin secretion leads to worsening of hyperglycemia and marks the progression from suboptimal glucose regulation to overt type 2 diabetes. Insulin resistance and β-cell dysfunction thus play critical roles in the pathogenesis as well as progression of type 2 diabetes [6-8]. As shown in Figure 2 Dysfunction of β-Cell in T2DM.

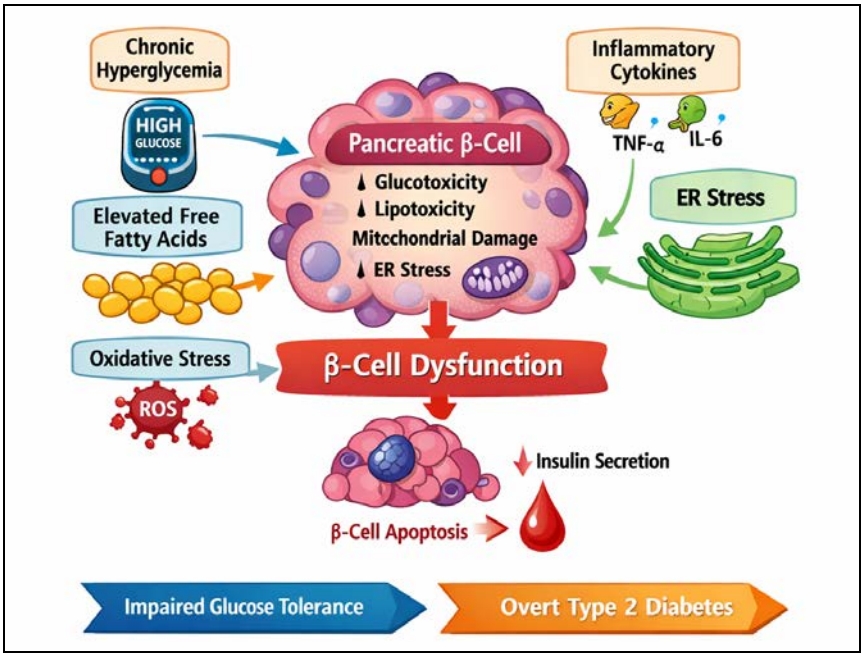

Fig 2: β-Cell Dysfunction in T2DM

3. Role of Obesity and Renal Glucose Reabsorption

Abdominal adiposity, a key feature of T2DM, plays a central role in the pathophysiology of T2DM. Adipose tissue is an active endocrine organ producing pro-inflammatory cytokines such as interleukin-6 (IL-6) and tumour necrosis factor-alpha (TNF-α). Insulin signalling pathways are disrupted by these cytokines, leading to insulin resistance in peripheral tissues. Obesity further augments glucose intolerance through metabolic dysregulation and chronic low-grade inflammation. Renal glucose handling also plays a key role in promoting hyperglycemia in T2DM. Glucose reabsorption in the proximal tubules is primarily mediated by sodium-glucose co-transporter 2 (SGLT2). In T2DM, SGLT2 expression and activity increase even in states of high blood glucose resulting in augmented glucose reabsorption. This pathogenesis prevents the excretion of glucose in urine to maintain hyperglycemia. Thus, both increased renal reabsorption and the inflammation associated with obesity contribute to the maintenance of elevated blood glucose levels and progression of disease [7, 9]. Figure 3 shows how obesity influences renal glucose handling by increasing the activity of SGLT2, leading to glucose reabsorption and persistent hyperglycemia.

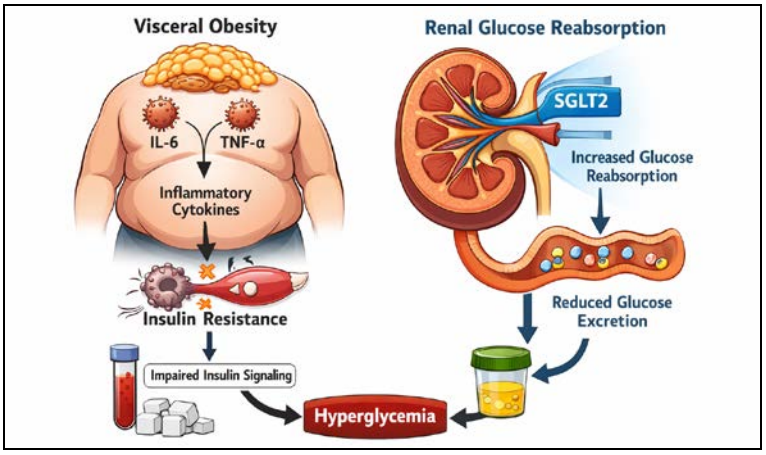

Fig 3: Role of Obesity and Renal Glucose Reabsorption

4. Chronic Hyperglycemia and Complications

Chronic hyperglycemia is one of the main features of T2DM and the decisive factor in its persistent sequel. Chronic hyperglycemia triggers a range of biochemical and molecular changes which over time impact tissues and organs. One of the predominant processes is the formation and accumulation of advanced glycation end products (AGEs) when sugars non-enzymatically glycate proteins, lipids, and nucleic acids. These Age form different tissues, altering protein structure and function and activating inflammatory signalling pathways. Moreover, persistent hyperglycemia triggers the production of reactive oxygen species (ROS), which results in oxidative stress. Besides the effects on DNA, proteins and cell membranes, it is also a contributor for endothelial dysfunction and inflammation [10, 11].

Endothelial dysfunction leads to reduced availability of nitric oxide, promotes impaired blood flow and thrombus formation, and causes abnormal vascular function. These changes ultimately lead to both microvascular and macrovascular complications. Examples of microvascular effects include damage to nerves, resulting in diabetic neuropathy; kidney failure (nephropathy) that occurs slowly over a period of time; and possible blindness or impaired vision (retinopathy). Examples of macrovascular problems include cardiovascular conditions such as peripheral vascular disease, coronary artery disease, and stroke. Hence, one of the major pathogenic factors in T2DM is chronic hyperglycemia that drives systemic complications. Consequently, maintaining effective glycemic control is critical to avert onset or delay of such complications and improve overall patient morbidity [10, 11]. Figure 4 shown the key complications associated with prolonged hyperglycemia in T2DM, highlighting both microvascular (nephropathy, retinopathy, neuropathy) and macrovascular (stroke, cardiovascular disease) outcomes.

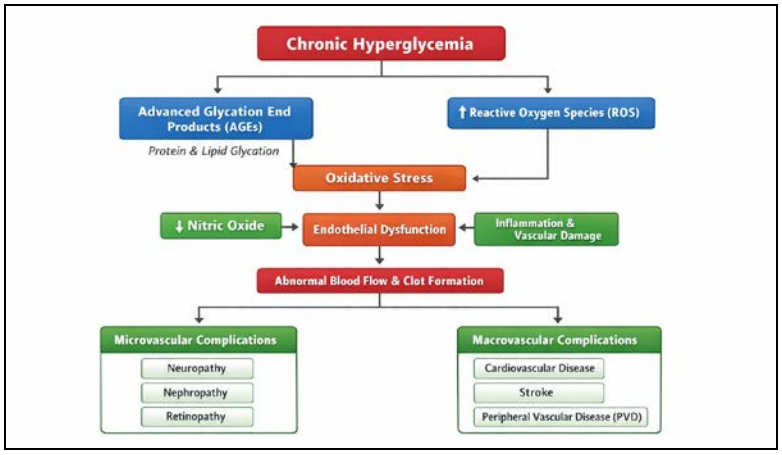

Fig 4: T2DM Complications Associated with Prolonged Hyperglycemia

World Wide Epidemiology of T2DM

The global burden of diabetes (mostly T2DM) has steadily increased both in terms of total number and prevalence from 2014 to 2024, as summarized in Table 1. In 2014, an estimated 422 million adults across the world were living with diabetes, and it was estimated that around 8.5% of adult population had diabetes. This figure increased to approximately 435 million in 2015, with prevalence also rising slightly (approximately 8.8 percent) representing the beginning of a steadily increasing epidemic. In 2017, diabetes had risen to approximately 451 million people worldwide, and the global manifestation approached 9.0%, which was due to lifestyle changes and demographic transition. In 2019, the rising trend persisted, and 463 million (9.3%) people were affected. Even in 2021, diabetes had significantly increased to 537 million people, and it confirmed that 10.5% people suffer from T2DM. The increase persisted in the years that followed, with an estimated 540 million and 545 million cases in 2022 and 2023. In 2024, 550 million people, that is half a billion people, suffer from T2DM, and this is rising, confirming that adults will be suffered from T2DM and will increase day by day [2, 12, 13]. The global burden of T2DM increased significantly between 2014 and 2024, as seen in Figure 5 and Table 1. These patterns highlight the critical need for coordinated protective strategies, such as increased health care access, early screening, and modification of lifestyle, to address this expanding epidemic and its reducing morbidity and death.

Table 1: World Wide growth of T2DM [2, 12, 13]

Year	Estimated Global Diabetes Cases (Millions)	Approx. in %
2014	~422 million	~8.5%
2015	~435 million	~8.8%
2017	~451 million	~9.0%
2019	~463 million	~9.3%
2021	~537 million	~10.5%
2022	~540 million	~10.6%
2023	~545 million	~10.7%
2024	~550 million	~10.8%

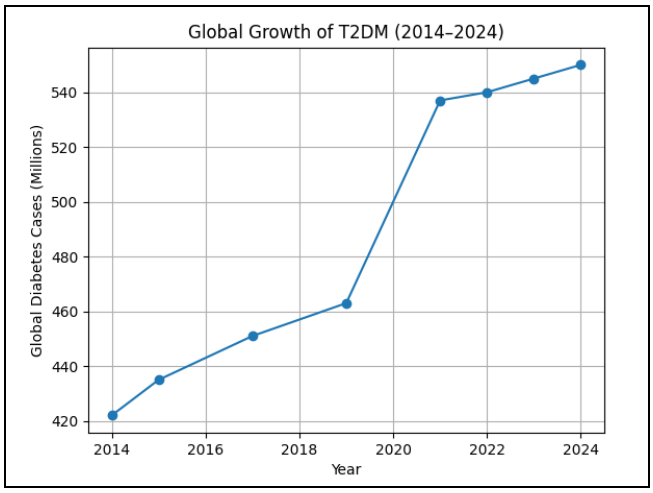

Fig 5: Global growth of T2DM from 2014 to 2024

High Protein Diet

1. Mechanism of Action

High-protein diets prevent type 2 diabetes by uncoupling critical metabolic processes associated with energy balance and glucose homeostasis. One of the primary mechanisms is increased satiety. Protein boosts the release of hormones that regulate appetite, including cholecystokinin (CCK), peptide YY (PYY) and glucagon-like peptide-1 (GLP-1), all of which inhibit hunger and promote satiety. This decreased calorie consumption facilitates the maintenance of an appropriate weight which is necessary for improving insulin sensitivity [14, 15].

On top of that, protein has a lower glycaemic response than carbs. By slowing gastric emptying and the rate of glucose absorption from intestine has potential to reduce both post-prandial blood glucose elevations as well as enhance overall glycaemic control. A high protein di*et al*so stimulates the development and maintenance of lean muscle mass; increased muscle mass enhances insulin mediated glucose utilisation and decreases insulin resistance, as skeletal exercise is one major site for glucose ingestion. Dietary protein modulates hepatic metabolism by regulating gluconeogenesis and reducing the liver's excessive glucose production. It may also reduce accumulation of visceral fat, which is highly correlated with metabolic dysfunction. In general, high-protein diets form useful nutritional strategies for risk reduction and maintenance of type 2 diabetes by virtue of their effect on satiety, glycaemic control, muscle preservation and insulin sensitivity [14-16].

2. Sources and Clinical Benefits

Proteins are derived from diverse food sources which can be broadly classified into plant and animal proteins as well as a few other functional sources. A varied intake provides sufficient amino acids and a balanced feed matrix, which are necessary for T2DM prevention [5].

Legumes, for example lentils, chickpeas, beans and peas are abundant in protein and dietary fibre (may help with glycaemic control). The most acclaimed plant proteins are soy-based foods like tempeh, tofu and soy milk, which contain all the essential amino acids. Some Nuts, seeds and whole grains have a low glycaemic index with high in antioxidants and such as walnut, brown rice quinoa, chia seed, oats, almond and sunflower seed. Not only Some Nuts, seeds and whole grains have low glycaemic index, which have high protein content — providing us with extra special benefits [17-19].

Sprouts, for instance, increase nutrient availability and digestion (e.g., sprouted mung beans and chickpeas). Animal sources of protein include fish such as salmon and sardines, which are high in omega-3 fatty acids, or eggs with their high biological value. Lean meats and poultry (chicken, turkey) when chosen carefully provide a superior protein with less fat. Apart from calcium and microbes, milk, yoghurt, paneer & cheese are excellent sources of protein. In cases where food sources of protein are insufficient, whey or plant-based protein powders can be used to augment protein intake. Fermented high protein foods provide an added metabolic advantage by helping the body properly digest and utilize food more efficiently, in turn promoting good intestinal health [17-19]. Major sources of Protein and their health benefits are summarized in Table 2.

There are several clinical benefits of high-protein diets in terms of managing and preventing type 2 diabetes. For one thing, they promote satiety, which reduces calorie intake and helps ensure effective weight control — both are key to decreasing insulin resistance. Second, eating protein helps preserve and build lean muscle mass, which increases

insulin sensitivity and the uptake of glucose. In addition, less blood glucose response was recorded in postprandial conditions with high-protein diets than heavy-carbohydrate foods which led to improved glycaemic control. They may also help reduce visceral fat storage, closely associated with metabolic diseases. Some studies. for example, have shown that a high protein diet can help improve lipid profiles by reducing triglycerides and promoting overall CVD health. High-protein diets also enhance digestive health, and when combined with high-fiber foods, delay glucose absorption. Overall, obtaining adequate quantities of high-quality protein from both plant- and animal-based sources can significantly help preserve general metabolic health and fend off type 2 diabetes [14-16].

Table 2: Protein Sources food [19, 20].

Category	Examples	Health Benefit
Plant-Based Proteins	Legumes & Pulses such as Tofu, tempeh, soy milk	Complete protein, contains essential amino acids
	Nuts & Seeds such as Almonds, sunflower seeds walnuts and chia seeds	Healthy fats, antioxidants, supports heart health
	Whole grains including oats, barley and brown rice.	It contains Moderate protein, low glycemic index, rich in fiber
	Sprouted mung beans, chickpeas	Improved digestibility, enhanced nutrient absorption
Animal-Based Proteins	Whole Eggs	High biological value, rich in vitamins
	Whole grains including Salmon and sardines	Omega-3 fatty acids, cardioprotective
	Lean Meat such as low-fat mutton.	High-quality protein, iron, zinc
	Dairy foods such as Milk, yogurt, paneer, cheese	Protein, calcium, probiotics
Additional Sources food	Fermented Protein Food product such as Tempeh, fermented soy.	It helps to improve gut health and digestion.

High-Fiber Diet

1. Mechanism of Action and Sources

High-fiber food is an important diet in keeping T2DM at bay due to its efficacy in improved glycaemic control and metabolic health. Dietary fibre can be broadly classified into soluble and insoluble types, both of which functions physiologically. The principal action of dietary fiber is that it slows gastric emptying and delays carbohydrate digestion and absorption. Soluble fiber absorbs water in the GI tract and forms a viscous gel-like matrix that decreases glucose absorption and blunts peak blood glucose responses following meals. It also promotes insulin sensitivity and keeps blood glucose levels stable. Moreover, the fermentation of fibers into SCFAs also boosts gut health, glucose metabolism, and prevents inflammation [21, 5].

Other, insoluble fibre, increases stool bulk and gut transit time, meaning that it soaks water up into the colon (gut), which helps to keep you regular. Both types of fibre help to increase satiety, which decreases energy intake overall and assists with weight management, an important risk factor in T2DM prevention. Important dietary sources of fibre: whole grains (oats, barley, brown rice), fruits (apples, oranges, berries), vegetables (leafy greens, carrots, broccoli) and legumes (lentils, beans and chickpeas). Other excellent sources of dietary fiber are nuts and seeds, including flaxseeds and chia seeds. The main sources of dietary fibre and their health benefits are shown in Table 3. Consequently, a high- fibre diet contributes to glycemic control in addition to benefitting other components of metabolic and gastrointestinal health, establishing its importance for prevention against T2DM [21, 5].

Table 3: The major sources of dietary fiber [21, 22].

Food Category	Examples	Health Benefit
Whole Grains	Oats, brown rice and barley	They are high in dietary fiber and have a low glycemic index, helping to maintain stable blood glucose levels.
Fruits	Oranges, apples and berries	Rich in soluble fiber and vitamins.
Nuts & Seeds	Flaxseeds, chia seeds	Provide dietary fiber and healthy fats, which help support heart health.
Vegetables	Broccoli, leafy greens and carrots,	Rich in High fiber and antioxidants.
Legumes	Chickpeas and beans	It provides both protein and fiber, which help improve glycemic control.

2. Clinical Benefits and Recommended Intake

The consumption of high-fiber food can provide major clinical advantages in the prevention and management of T2DM by way of better glycemic control, increased insulin sensitivity, and improvement of general metabolic health. Aside from the most apparent benefit of dietary fiber is to control blood sugar levels. Soluble fiber slows down gastric emptying, which in turn delays carbohydrate digestion and absorption and results in a gradual increase of blood glucose after a meal. This helps to avoid sudden spikes in glucose and decreases insulin demand. Furthermore, fiber increases insulin sensitivity which means tissues make better use of glucose.

Also Dietary fibre plays an important role in maintaining weight control. Greens' high fibre makes you feel fuller for longer, which decrease your overall calorie intake and this is pertinent since obesity is a risk factor for T2DM. Finally, in patients with cardiovascular disease who struggle with type 1 or type 2 diabetes, fibre improves lipid profiles as seen by the lowering of total cholesterol and low-density lipoprotein (LDL) profiles. Another remarkable benefit its influence on gut health. Fermented fibre has short-chain fatty acids (SCFAs) and play significant role to reduce inflammation, improve metabolic function and affect the composition of the gut microbiota [21, 5]. The amount of dietary fibre necessary for good health varies by sex and age, despite the strong evidence associating fibre type and health. However, the WHO mentioned a daily intake of 25–30 g/d.

As such, gradually increasing your fibre intake and drinking enough water is a good way to prevent gastrointestinal

discomforts like bloating or constipation. Daily fiber intake can be achieved through a balanced diet consisting of whole grains, fruits, vegetables, legumes, nuts and seeds. In general, sufficient fiber intake is warmly suggested as one of the basic factors in healthy diet that remarkably decreases chances of developing T2DM, such as to slow down development aspect along with enhancing long-term health [21, 23].

Low-Carbohydrate Diet

1. Types and Sources

Low-carbohydrate diet as a therapeutic nutritional strategy in T2DM prevention and control. It deliberately excludes all carbs, particularly refined and high-glycemic index ones, in favour of nutrient-dense substitutes. This approach is best practice to moderate blood glucose spikes and improve overall health [19, 24]. The classification of low-carbohydrate diets based on carbohydrate restriction levels is presented in Table 4. Low carbohydrate diets vary by how seriously they prohibit consumption of carbohydrates. A moderate low-carbohydrate diet is a sustainable and long-term approach, providing between 26% and 45% of total daily energy from carbohydrates. A very low carbohydrate diet (including ketogenic diets) restricts carbohydrate intake to <10–25% of total energy, which promotes the use of fat as fuel. These have differences in dietary patterns depending on individual needs, health status, and clinical goals [19, 24, 26].

Nutritionally, carbs are broken down into two general categories: refined (simple) and complex. Refined carbohydrates, like those found in white bread, polished rice, sugar-rich foods, and packaged snacks are digested quickly and result in a harsh spike of blood glucose levels. In contrast, simple carbohydrates from refined sugars can cause blood sugar spikes as they are absorbed quickly, while complex carbohydrates such as those found in whole grains, vegetables and legumes take longer to digest and have a lower glycemic index. Refined carbohydrates are limited in a low-carbohydrate diet while complex carbohydrates are included at controlled portions. A detailed overview of carbohydrate types and their respective food sources within a low-carbohydrate dietary framework is provided in Table 4 [19, 26].

Table 4: Types of Carbohydrates in Low-Carbohydrate Diet and their Sources of Food [19, 24, 26].

Type	Carbohydrate Intak	Sources Food
Moderate Low-Carb	26–45% of energy	Oats, multigrain roti and grilled chicken.
Low-Carb	10–25% of energy	Mushrooms, boiled eggs, almonds and Grilled chicken.
Very Low-Carb (Ketogenic)	<10% of energy	Cheese, boiled eggs, Bullet coffee.

2. Clinical Benefits, Mechanism and Recommended Intake

A low-carbohydrate diet offers significant clinical benefits in the prevention and management of T2DM by improving glycemic control, reducing insulin resistance, and supporting weight management [24].

Mechanism of Action

This common mechanism consists of an overall reduction in carbohydrate intake, which decreases glycemic load and lowers postprandial blood glucose spikes. Less carb means less demand of insulin secretion, which in turn facilitate the body to become more sensitive to insulin. Furthermore, carbohydrate restriction enhances fat utilization, particularly in severe low-carbohydrate (ketogenic) diet-induced ketosis. Low-carbohydrate diets also lower hepatic glucose production and enhance metabolic flexibility. These diets focus on avoiding refined carbohydrates and sugars, which will prevent rapid spikes in blood glucose levels. Moreover, higher protein and fat consumption induce satiety, resulting in lower caloric consumption and successful weight management [19, 26].

Clinical Benefits

One of the major benefits of a low-carbohydrate diet is improved glycemic control, reflected in reduced fasting and postprandial blood glucose levels. It also contributes to significant weight loss, particularly by reducing visceral fat, which is closely associated with insulin resistance. Improved lipid profiles, including reduced triglycerides and increased high-density lipoprotein (HDL) cholesterol, further support cardiovascular health. Additionally, low-carbohydrate diets may reduce inflammation and improve markers of metabolic syndrome. These benefits collectively lower the risk of progression to T2DM and its associated complications [26, 27].

Recommended Intake

This common mechanism consists of an overall reduction in carbohydrate intake, which decreases glycemic load and lowers postprandial blood glucose spikes. Less carb means less demand of insulin secretion, which in turn facilitate the body to become more sensitive to insulin. Furthermore, carbohydrate restriction enhances fat utilization, particularly in severe low-carbohydrate (ketogenic) diet-induced ketosis [19, 24]. Low-carbohydrate diets also lower hepatic glucose production and enhance metabolic flexibility. These diets focus on avoiding refined carbohydrates and sugars, which will prevent rapid spikes in blood glucose levels [19, 24].

Role of Nutrition in T2DM Prevention

Nutrition is a vital predictor of the metabolic state, which is ascertained by glucose metabolism and, hence, general metabolic health such as insulin sensitivity and body weight), and it is crucial in preventing type 2 diabetes. Dietary habits are one of the most modifiable risk factors; thus, applicable nutritional measures that could remarkably reduce the outbreak and progression of type 2 diabetes are desperately needed. It reduces the need for insulin secretion and stabilises blood glucose levels. It has been demonstrated that diets high in whole foods such as vegetables, whole grains, fruits, nuts, and seeds provide vitamins, minerals, and dietary fibre. Dietary fiber especially soluble one decreases gastric emptying and absorption of carbohydrates in the small intestine that leads to the gradual increase of blood glucose level which improves glycemic control. Such system avoided postprandial glucose peaks, one of the principal factors for insulin resistance [1, 22].

T2DM is prevented by the protein intake of essential dietary. High Diet in protein are more complete because they regulate hunger hormones and reduce calorie intake, which promotes effective weight and body maintenance. Obesity is one of the most significant risk factors for T2DM

and insulin resistance, which is why regulating a healthy body weight is important. Additionally, protein plays a vital role in the recognition of lean muscle mass that assists glucose uptake, along with increased insulin sensitivity. Protein helps maintain lean muscle mass, which increases insulin sensitivity and facilitates the uptake and utilisation of glucose [1, 22]. Soft drinks, White bread, and snacks are examples of fast-acting carbs that have a high glycaemic index and cause rapid rises in blood sugar levels. Blood glucose levels can be stabilised and metabolic stress can be decreased by substituting complex carbohydrates with low glycaemic index for refined carbs. Blood glucose levels can be stabilised and metabolic stress can be reduced by substituting complex carbohydrates with low glycaemic index for refined carbs.

Additionally, consuming unsaturated fats, such as nuts, avocados, seeds, and olive oil, decreases inflammation and blood lipid profiles improves, which assists avoid cardiovascular disorders that are common in T2DM people. Moreover, high saturated fats induce insulin resistance of pancreatitis [28, 29].

In nutritional management of energy balance, there is a significant correlation between excess calories, weight gain with type 2 diabetes. Metabolic plasticity is also influenced by timely meals and adequate fluids. People can remarkably reduce their risk of T2DM by maintaining a balanced diet and regular exercise, according to the WHO. Nutrition affects metabolic processes glycaemic regulation and body weight status, it is a major avoidable factor in the pathogenesis of T2DM. Healthy figures that are decorated using protein and fibre - low-carbohydrate diets with refinements, with a healthy lifestyle, reduce the risk of T2DM while promote long time health [28].

The Combined Diet's Synergistic Effects

When diet linked with regular exercise, high-protein with low-carb diet can have an strong impact on both good glycaemic control and the prevention of T2DM. Low carbohydrate intake lowers the glycaemic load and postprandial blood glucose rise. Additionally, dietary fibre slows down the stomach's emptying and the absorption of carbs, causing the blood to gradually release glucose [28]. This phenomena is strongly driven by a high-protein diet. Proteins strengthen the specific hormones that regulate appetite, controlling hunger. When combined with foods high in fibre that produce satiation, this leads to a feeling of fullness. One of the greatest ways to lower your risk of T2DM is to maintain a normal body weight because obesity, fat buildup, is a major cause of insulin resistance.

Increased insulin sensitivity is the second significant synergistic effect. Increased glucose absorption is linked to maintaining and increasing body mass, which is normalised by higher protein intake. On the other hand, short-chain fatty acids (SCFAs), which are generated when fibre ferments in the gut, enhance insulin activity and reduce inflammation. Reducing carbohydrates further improves the insulin or pathway metabolic load. Additionally, a combination diet can help heart function and lipid metabolism. In particular conditions, consuming more fibre and good fats lowers cholesterol levels and the risk of atherosclerosis, whereas consistently consuming fewer processed carbohydrates lowers serum triglyceride levels [16, 24].

Beneficial microbiota profile is also from the combined diet, which promotw gut digestion. Mannose is a natural prebiotic fibre with lower sugar content, promotes metabolic health, and reduces systemic inflammation. Therefore, the overall benefits of a high-fiber, high-protein, low-carb diet provide a more widespread strategy for preventing T2DM. Overall, this body of evidence demonstrates that this dietary pattern provides a long-term approach that simultaneously addresses glycaemic control, weight management, insulin sensitivity, and inflammation [16, 24].

Daily Lifestyle Modifications

Significant improvements in metabolic health, insulin sensitivity, and target body weight can be achieved with small lifestyle changes, preventing the development with a lowered risk for T2DM. Regular physical activity is one of the most significant changes. 150 minutes of moderate-intensity exercise each week, such as brisk walking, cycling, or swimming, improves insulin sensitivity and makes it easier for glucose to enter muscles. Additionally, aerobic activity controls body weight and reduces visceral fat, which is a major risk factor for T2DM. Exercise nutritious diet can help prevent insulin resistance by lowering body mass index (BMI). Diabetes risk can be waned and metabolic success can be greatly enhanced by modest weight loss (5–10% of body weight) 247. This entails consuming a diet rich in protein, fibre, and healthy fats rather than processed foods, sweets, and refined carbs. In addition to preventing intemperance in meals, portion control and attentive eating also contribute to static blood glucose levels [4]. However, accurate sleep is important for controlling metabolism. Increased insulin resistance and a higher risk of T2DM are linked with poor sleep or less than seven hours of sleep per night.

Sticking to a regular sleep schedule can help keep these hormones balanced and your body healthy. The stress management is just as essential because chronic stress results in a chronically increased production of the hormone cortisol, which ultimately also increases blood glucose and induces insulin resistance. Often, it can be helpful to know and we must use our techniques yoga, meditation, deep breathing exercises and relaxation practices. Similarly, the avoidance of unhealthy behaviours as smoking or aggressive drinking is also advised [30, 31]. These increase risk for diabetes and cardiovascular diseases, worsens the metabolic health above. Now that is the right amount of water and meal at regular intervals would help us be stable from a metabolic perspective as well as provide digestion. The Who reports that other lifestyle modifications of healthy eating and regular physical activity were shown to substantially lower the risk of T2DM. Making Daily Changes to our Lifestyle Combined With a Healthy Eating Plan Conclusion — As proved in the studies by Spiegel *et al*. (1999) and Willi *et al*. (2007), small but constructive changes in lifestyle measures everyday along with a balanced diet are key towards the prevention of T2DM; thus overall creating a healthily plausible life style for both present and future generations [30].

Challenges and Limitations

The sustainable dietary strategy keeping high protein, high fiber and low carbohydrates are effective for T2DM prevention; however, many concerns and limits can restrict its implementation. Adhering to such a limited diet is one of

the greatest challenges. Because of the limited food intake and lack of variety, strict dietary patterns (such as low carbohydrate or ketogenic diets) may become difficult to maintain over the long-term. Indeed, for many it is almost impossible to avoid commonly consumed carbohydrate-rich foods on a regular basis, especially in the environments with grain-based staple and as part of traditional diet. Culture and society mean the people themselves play a major role. Modified healthier dietary patterns may not be accepted or adopted due to traditional food habits, social interactions and family food favoritism. The staples that have more carbohydrate like rice and bread are peoples' daily meal, so dietary change is not easy to be adopted. Financial limitations may also have an influence on adherence. For example, nuts, seeds, and high-quality proteins may be expensive in some are [1, 33, 34]. These costs associated with these dietary factors can make it difficult for residents from lower socioeconomic backgrounds to follow low GI/high protein dietary practices consistently.

Another drawback is the potential for nutritional imbalance. If low-carb diets are poorly executed, they might deprive you of dietary fibre, vitamins, and minerals, among other important nutrients. Age, gender, health, and degree of activity all affect the nutrients needed. Here isn't a single medication that works for everyone, and the majority of us need individualised dietary suggestions in order to react the best. Lastly, the use of preventative measures may be hampered by a lack of knowledge about the features of a healthy diet. Due to this, some people disregard dietary advice, which calls both knowledge and clinical experience [34, 35].

Conclusion

Day by day T2DM is global health issue due to modified by modifiable lifestyle and dietary factors. In this review, we highlight the potential impact of nutrition in risk factor of T2DM and progression of prevention, dietary exposure suggests that a high protein-pattern diet is associated with decreased carbohydrates effective for lowering fibre. Reduced net grams, specifically for refined and high glycaemic index carbohydrates, are the opposite side of an equation that lowers insulin load and postprandial glucose excursions. While these dietary components have their own significant effects on the pathophysiology of T2DM through a variety of protective pathways linked to obesity, inflammation, and sensitivity to insulin, when combined, they have been proven to work synergistically against a variety of metabolic pathways involved in the disease. However, possible drawbacks must be handled by adherence to dietetics practices, local food preferences, financial situation, and the risk of poor nutrition through careful planning, educational support, and customised approach. Overall, a lifestyle with healthy paired with a high-protein, high-fiber diet that reduces the incidence of T2DM can be a viable strategy. We think that utilising long-term prevention in conjunction with broad public health initiatives and individual dietary counselling is the only fair, viable, and efficient way to fight the rising incidence of this illness.

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Conflict of Interest

The author declares no conflict of interest.

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