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KETOGENIC DIET IN THE MANAGEMENT OF DIABETES

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ABSTRACT

People try different diet plans for diabetes. Among the most popular diet plans, Ketogenic diet is the most popular one for diabetic patients. Ketogenic diet improves health through a metabolic switch in the primary cellular fuel source to which one's body and brain are adapted. When metabolism switches from relying on carbohydrate-based fuels (glucose from starch and sugar) to fat-based fuels, fat metabolism products are formed which are called ketones which promote positive changes in the cells, and this translates into better overall health. Ketosis is simply a normal metabolic pathway in which body and brain cells utilize ketones to make energy, instead of relying on only sugar (carbohydrates). Ketogenic diet has broader uses apart from Diabetes which can treat medical conditions such as Autism, Epilepsy, Cancer, and Alzheimer's as well. The ketogenic diet has the potential to decrease blood glucose levels and minimizing carbohydrate intake is often recommended for people with type 2 diabetes because carbohydrates turn to sugar and in large quantities, can cause spikes in the blood sugar levels.

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INTRODUCTION

Diabetes mellitus is the set of metabolic disorders marked by raised blood glucose levels that is due to the altered in insulin secretion or action. Diabetes can cause debilitating and costly complications that affects blood vessels of eye, neurons of brain and nephrons of kidneys. Most of the health and economic burden of diabetes can be averted through known prevention measures and medications [1].

The ketogenic diet was originally developed in 1924 to treat epilepsy, but the effects of this eating pattern are also being studied for type 2 diabetes. Recent research suggests that high fat, very-low carb diets have another benefit: They may help control glucose, triglycerides, insulin, and body weight in people with diabetes. Special diets for type 2 diabetes often focus on weight loss, but the ketogenic diet, high in fat and low in carbs, can potentially change the way body stores and uses energy which can reduce the diabetic symptoms. The ketogenic diet may improve blood glucose levels while also reduce the need for insulin.

Epidemiology

Diabetes is growing in status to be one of the most potential epidemics in India, as more than 62 million diabetic individuals are currently diagnosed with the disease. As per the 2015 data, India had 69.2 million people living with diabetes (8.7%). According to the latest estimates of diabetes in 2013, it has a global prevalence of 382 million people and is expected to rise to 592 million by 2035 [2].

Table 1 Types, signs & symptoms and mechanism of Diabetes [1].

TYPE	SIGNS & SYMPTOMS	MECHANISM
Pre Diabetes	Polydipsia, Polyphagia, Nocturia, Blurred vision, Weight loss, Tingling sensation of limbs	It is characterized by Impaired Glucose Tolerance (IGT) or Impaired Fasting Glucose (IFG). Usually it precedes type 2 diabetes. This stage is often referred to as the "Border-line diabetes"
Type 1 DM	Extreme tiredness, Polyuria, Blurred vision, Weight loss, Polydipsia	It is characterized by the body's inability to produce insulin due to autoimmune destruction of the beta cells in the pancreas.
Type 2 DM	Lethargy, Delayed healing, Excessive sleep, Weight gain, Headache	In type 2 DM, the body either produces inadequate amounts of insulin or insulin resistance has developed.
Gestational DM	Mood swings, Nausea/Vomiting, Fatigue, Infections, Polyuria, Weight gain	The precise mechanisms of gestational diabetes is unknown but, it is characterized with increased insulin resistance.
MODY	Hyperglycemia, Polydipsia, Polyuria	It refers to hereditary forms of diabetes mellitus caused by mutations in an autosomal dominant gene disrupting insulin production.
LADA	Polydipsia, Polyuria, Blurred vision, Fatigue	It is characterized by the presence of autoimmunity and immune mediated β -cell dysfunction.
Secondary DM	Hyperglycemia	It is characterized by gene disorders (Wolfram syndrome), damage to the exocrine pancreas (Fibrocylculouspancreatopathy), drug-induced diabetes (thiazide diuretics, atypical antipsychotics, corticosteroids, protease inhibitors).

DM-Diabetes Mellitus, MODY- Maturity Onset Diabetes of the Young, LADA- Latent Autoimmune Diabetes of Adults

Causes [3]

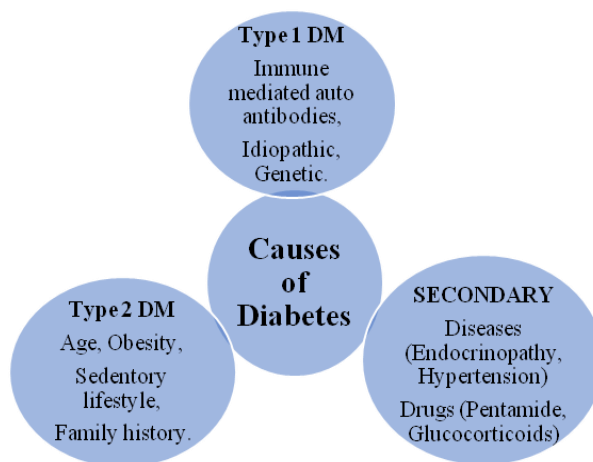


Figure 1 Causes of Diabetes.

Criteria for the Diagnosis of Diabetes [4]

- HbA1C (Glycated Hemoglobin) $\geq 6.5\%$.
- Fasting Blood Glucose ≥ 126 mg/dl (7.0 mmol/l).
- 2-h plasma glucose ≥ 200 mg/dl (11.1 mmol/l) during an oral glucose tolerance test (OGTT).
- In a patient with typical symptoms of hyperglycaemia, a random plasma glucose ≥ 200 mg/dl (11.1 mmol/l).

Management of Diabetes

The main goal in management of diabetes mellitus is to eliminate symptoms and to prevent the complications. Multidisciplinary team of health professionals with expertise in diabetes can provide best diabetes care, working in collaboration with the patient and family. Management includes the following:

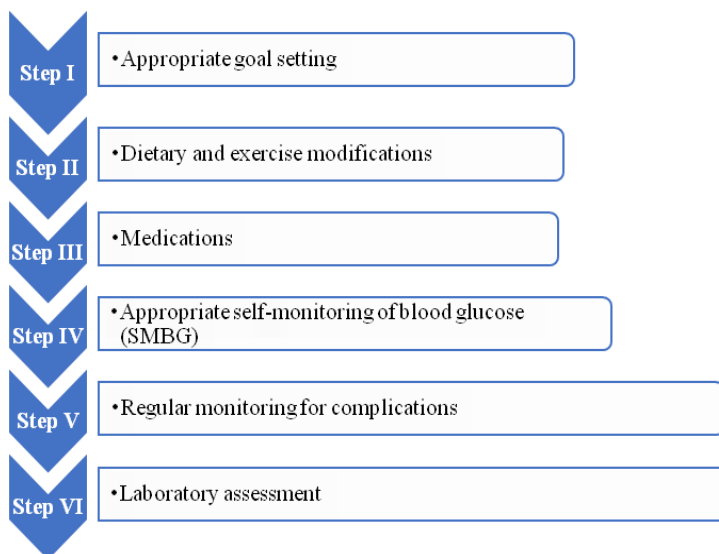


Figure 2 Approach Considerations for management of Diabetes.

Pharmacological management

Initiation of pharmacological therapy is associated with better glycemic control and reduced long-term complications in diabetes. Drug classes used for the treatment of diabetes include the following:

Table 2 Pharmacological management of Diabetes.

DRUG CLASS	SITE OF ACTION	MECHANISM	EXAMPLES
Sulfonylureas	Pancreas	Secretagogues	Glimepiride, Glipizide.
Biguanides	Liver, Muscles	Sensitizers	Metformin
Meglitinides	Pancreas	Secretagogues	Repaglinide
Alpha-glucosidase inhibitors	Intestine	Absorption inhibitors	Acarbose, Voglibose.
Thiazolidinediones	Liver, Muscles	Sensitizers	Pioglitazone, Rosglitazone.
GLP-1 agonists	Intestine	Stimulates insulin secretion	Exenatide, Liraglutide.
DPP-4 inhibitors	Intestine	Stimulates insulin secretion	Sitagliptin, Saxagliptin.
SGLT-2 inhibitors	Kidney	Na-glucose co-transport inhibitor	Dapagliflozin, Empagliflozin.
Insulin	Pancreas	Glucose metabolism	Humulin, Aspart, Lispro, Humalog.

GLP-glucagon-like peptide, DPP- dipeptidyl peptidase, SGLT-Sodium-glucose co-transporter

Role of Ketogenic Diet In Management of Diabetes [5-7]

Ketogenic diet is high in fat and low in carbohydrates and, can potentially alter the way body uses energy and stores it. In ketogenic diet, body converts fat to produce energy, instead of sugar. The main goal of the ketogenic diet is to make the body use fat for energy instead of carbohydrates or glucose. The individuals on the ketogenic diet produce most of their energy from fat, with very little of the diet coming from carbohydrates.

Types of Ketogenic Diet

There are several versions of the ketogenic diet, they are as follows:

Standard Ketogenic Diet (SKD):

This is a very low- carbohydrate with moderate-protein and high-fat diet. It typically contains 70% fat, 20% protein and only 10% carbohydrates.

Cyclical Ketogenic Diet (CKD):

This diet involves periods of higher-carbohydrates, such as 5 ketogenic days followed by 2 high- carbohydrates days as a cycle.

Targeted Ketogenic Diet (TKD):

This diet let on adding carbohydrates around the workouts.

High-Protein Ketogenic Diet (HPKD):

This is similar to a standard ketogenic diet, as name itself indicates it includes more protein. The ratio is often 60% fat, 35% protein and 5% carbohydrates.

However, only the standard and high-protein ketogenic diets have been studied extensively. Cyclical and targeted ketogenic diets are recent types, and majorly used by bodybuilders or athletes. The standard ketogenic diet (SKD) is the most researched and recommended.

Composition of Ketogenic Diet.

Diet type	Breakfast (grams)	Lunch (grams)	Dinner (grams)	Total (grams)	Proportion
Fats	49	70	61	180	70 %
Proteins	12	21	19	52	20 %
Carbohydrates	6	11	9	26	10 %

Foods Recommended In Ketogenic Diet

Some healthy foods that are commonly used in the ketogenic diet include:

Carbohydrates	Fats	Proteins
<ul style="list-style-type: none"> Grain based foods like Rice, Oatmeal, Barley, Bread, Cereals and Pasta. Vegetables like Potatoes, Peas, Lettuce, Cucumber, Broccoli and Corn. Dairy products like Milk and Yogurt. 	<ul style="list-style-type: none"> High fat foods like Lard, Fatback, Egg yolks, Pork, and Beef. Dairy products like Cheese, Cream, Butter and Whole milk. Oils like coconut oil, Avocado oil, Canola oil, Olive oil, Peanut oil and Sesame oil. Nuts like Almond, Cashews, Peanuts and Walnuts. 	<ul style="list-style-type: none"> Beans like black, kidney and pinto. Lentils such as brown, green and yellow. Peas like black-eyed and split. Poultry foods like Chicken, Turkey and Egg whites. Sea foods like Tuna, Salmon, Cod, Clams, Crab, Lobster, Shrimp and Oysters.

Foods To Avoid In Ketogenic Diet

- Grains or starches like wheat-based products, pasta, rice, pasta, cereals etc.
- Foods that contain sugar like fruit juice, soda, ice cream, smoothies, cake, candy etc.
- Root vegetables and tubers like potatoes, sweet potatoes, parsnips etc.
- Alcohol, due to its carbohydrate content, many alcoholic beverages can throw you out of ketosis.
- Some sauces since they often contain sugar and unhealthy fat.

Mechanism of Action of Ketogenic Diet

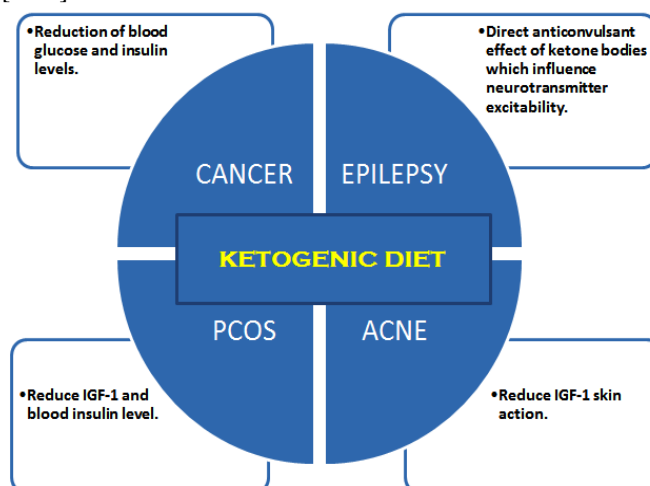
The diet aids to decrease the body's demand for insulin which has benefits for people with diabetes. On a ketogenic diet, the carbohydrates intake is limited that the blood glucose levels are kept at a low but healthy level which encourages the body to break down fat into a fuel source known as ketones. The process of breaking down or burning body fat is known as ketosis. The ketogenic diet has the potential to decrease blood glucose levels. People with diabetes are recommended for controlled carbohydrate intake as it is converted into sugar and can cause spikes in blood sugar levels [6, 7].

Benefits of Ketogenic Diet

Apart from management of diabetes, it also has other benefits like,

- Reducing triglyceride levels
- Reducing high blood pressure
- Improving mental performance
- Raising HDL (High-density lipoprotein) cholesterol levels

Other Indications of Ketogenic Diet [8-10]



PCOS -Polycystic Ovary Syndrome
IGF-1 -Insulin like Growth Factor

Recent studies have suggested that ketogenic diet has benefits for various health conditions such as:

- Cardiovascular diseases: The ketogenic diet can diminish the risk of heart diseases by reducing body fat, increasing HDL levels, maintaining blood pressure and blood sugar levels as well.
- Cancer: Ketogenic diet can diminish the growth of the tumor.
- Central Nervous system: This diet can significantly reduce the symptoms of Alzheimer's and diminishes the disease progression.
- Epilepsy: Research suggests that ketogenic diet can lower the frequent occurrence of seizures in children.
- Polycystic ovary syndrome: The ketogenic diet has a prominent role in management of PCOS by reducing insulin levels in the body.
- Acne: Since insulin levels get lowered in Ketogenic diet it may help in the management of acne.

Adverse Effects Associated With Ketogenic Diet

- Muscle cramps
- Bad breath
- Changes in bowel habits
- Loss of salts
- Keto-flu
- Loss of energy

Monitoring Ketogenic Diet

There should be keen monitoring of both blood sugar levels and ketone levels to make sure that the diet is not causing any sort of adverse reactions. Once the body adjusts to the diet, patients may require monitoring of once or twice in a month to ensure that their blood glucose, ketone and other parameters are under control. It also helps in proper dosage adjustment according their specific parameters. Even when symptoms improve, it's still important to keep up with regular blood glucose monitoring.

CONCLUSION

Ketogenic diet can be evidently considered as the choice of diet by any age group which can significantly shows amazing results in lowering the blood glucose levels. If one has a condition like diabetes, regular workout should be carried out while following any type of ketogenic diet plans which is different from the regular eating habits for faster results.

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Conflict of Interests

Nil

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