

Ketogenic Diet for Human Health

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Abstract

Ketogenic diet is a high fat, moderate protein, low carbohydrate diet in which energy source is ketones instead of glucose, which was initially designed to treat epilepsy but it proved in delivering many other health benefits including weight loss, fat loss, improves glucose and insulin levels, sometimes it results in skin glow and many others health benefits. Intake of ketogenic diet will place your body into a state of “ketosis”. A process when human body becomes a fat burner rather than sugar burner. The present study includes brief description about ketogenic diet and its types, history, biochemistry, its benefits and their side-effects.

Keywords: Diet; Ketogenic; Health; Energy; Fat; Food

Introduction

The widespread of obesity or overweight issues rising rapidly over few centuries, globally and in India. Personshaving body mass index 25 or more are obese. Obesity generally occurs when consumption of calories is more than required and their expenditure is less. The excessive body fat causes the risks of serious health problems like Type 2 diabetes, hypertension, PCOS/PCOD, cardiovascular disease, arthritis, sleeping disorder, even some form of cancer, some physiological issues like low- esteem, lethargic, depression. Treatment of obesity consists of lifestyle changes such as modification in diet and inclusion of physical activities/exercises. One such diet which is helpful in weight reduction and gaining popularity is Ketogenic diet.

History and Original use

Originally it was developed for the treatment of epilepsy and in 1921 by Rollin Turner the term coined as ketogenic diet. Ketogenic diet were a common practice in the treatment of epilepsy since 1920’s and 1930’s based on studies that prolonged periods of fasting reduced seizure activity in epileptic patient. Although mechanism of ketogenic diet works on epilepsy are still not fully understood. But now a day it is widely used for the treatment of obesity.

What are Ketogenic diets?

Ketogenic diet is a high fat, moderate protein and low carbohydrate based diet. Ketogenic diet is extremely high in fat content, and forces your body to produce and use ketones as an energy source. Ketones production from β -oxidation of Acyl CoA showing in figure 1. There are 3 types of ketones produces in body such as acetoacetate, β -hydroxybutyrate, and acetone. β -hydroxybutyrate is the most prevalent and most energy efficient ketones body. Produced in quantities after sustained carbohydrates restriction. Used as energy in muscles, heart brain and other tissues. The type of dietary fat consumed in ketogenic diet is an important factor influencing an individual’s ability to remain in a metabolic state of ketosis. Depending on ratios of macronutrients (carbs, protein and fat) there are 4 types of Ketogenic diet (Figure 1) [1].

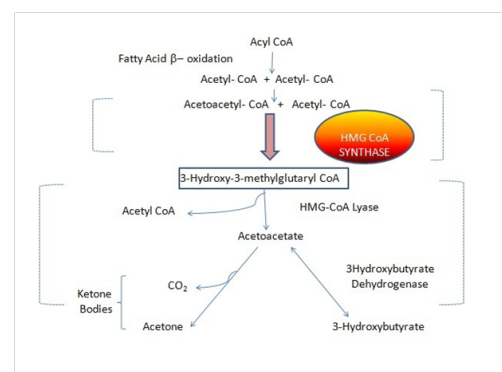


Figure 1. Showing conversion of Acyl-CoA to ketone bodies.

Types of Ketogenic diet

1. Standard Ketogenic diet (SKD): This is high fat, moderate protein and very low carbohydrate diet. It contains 70-75% fat, 20% protein, and 5-10% carbohydrates.
2. High protein Ketogenic diet: This diet includes more protein and their macronutrient ratios are fat 60%, protein 35% and 5 % carbohydrate.
3. Cyclic Ketogenic diet: This diet includes regular periods of high carbohydrates days in Ketogenic diet. For example 5 days ketogenic diet followed by 2 high carbohydrate day as a cycle.
4. Targeted Ketogenic diet: This diet contains more carbohydrate around the intensive physical workout duration to increase workout stamina and prevent muscle loss. However the percentage of carbohydrates depends of types and duration of workout.

Biochemistry of Ketosis

The production of ketones bodies include fat from fatty acids of diet as well as of adipose tissue. The process of ketone body formation is known as ketogenesis occurs in the mitochondrial matrix of liver cells. The adipokine by signaling messages to high glucagon, epinephrine and lower insulin lead to action of fatty acids release. High glucagon and low insulin correspond to times of low glucose availability such as fasting or starving. Fatty acids get bound to the coenzyme-A and after binding these fatty acids get penetrated into mitochondria. Once inside the mitochondria, the bound fatty acids are used as fuel in cells primarily through β -oxidation, which divides two carbons from the Acyl-CoA molecule in every cycle to form acetyl-CoA. Acetyl-CoA enters the citric acid cycle, where it undergoes an aldol condensation with oxaloacetate to form citric acid; citric acid then enters the krebs cycle, which brings in the original fatty acid per carbon high energy yield. Acetyl-CoA can be metabolized through the krebs cycle in any cell, but it can also undergo ketogenesis in the mitochondria of liver cells. When glucose availability is low, oxaloacetate is diverted away from the krebs cycle and is instead used to produce glucose via gluconeogenesis. This utilization of oxaloacetate in gluconeogenesis can make it unavailable to condense with acetyl-CoA, preventing entrance into the krebs cycle. In this situation, energy can be yield from acetyl-CoA through ketone production [2].

During ketogenesis process acetyl-CoA molecules (2) condense for the formation of acetoacetyl-CoA with the help of thiolase enzyme. Whereas, Hydroxy- β -methylglutaryl-CoA lead to formation of acetoacetate (ketone body) with the help of HMG-CoA lyase. Then, acetoacetate may reversibly get converted into different ketone body known as D- β -hydroxybutyrate via D- β -hydroxybutyrate dehydrogenase. Optionally, acetoacetate may spontaneously get converted into acetone (third ketone body) and CO₂. Finally, live cannot use formed ketone bodies.

List of acceptable ketogenic food item

Seafood: Tuna, shrimp, sardines & all sea food.

Vegetables: Cabbage, broccoli, cauliflower, onion, spinach, tomato, cucumber, bell pepper, mushroom, eggplant, lady finger & all low carb veggies.

Meat & Poultry: Chicken, egg, bacon, beef, pork.

Dairy: Yogurt, almond milk, coconut milk, paneer, butter, mozzarella, heavy cream, mayonnaise.

Fruits: Strawberries, black berries, raspberries, watermelon, avocado, olive.

Nuts & Seed: Almond, walnut, peanut, pistachio, flax seed, sunflower seed, pumpkin seed.

Healthy fats: coconut oil, olive oil, avocado oil, MCT oil (Table 1) [3].

Meal	Menu
Early morning	Lemon cinnamon water(warm) - 1 glass Soaked almond - 5pc
Breakfast	Cheese omelette -134g
Mid-morning	Coconut water -250ml
Lunch	Keto roti -2 + palakpaneer -150g + butter -1tsp + salad
Evening	Green tea - 1 cup + roasted flax seeds -2tsp
Pre-dinner (30min before)	Lemon chia water - 1 glass
Dinner	mix veg. soup -150ml + paneerbhurji -100g
Post dinner	Green tea - 1 cup

Table 1. Sample Menu of Ketogenic Diet Plan (1200kcal).

Issues of concern

Side-effects: Starting of Ketogenic diet, shifts your body energy source from sugar to body's stored fat. In the process of body fat breakdown, the body produces ketones, which are then removed by the body through frequent and increased urination. This may leads to dehydration and keto-flu; symptoms include fatigue, dizziness, insomnia, irritability, nausea, muscle soreness, acidosis, and light headache. With this frequent urination loss of electrolytes occurs, causes numbness, brain fog or difficulty in concentration. These short term side-effects of the Ketogenic diet are well reported and established. These side-effects can be overcome with the inclusion of electrolyte drinks and dietary fiber in diet. However the long term side effects of Ketogenic diet are still not well established due to limited studies. Long term side-effects consists kidney stones, hypoproteinemia, macronutrient deficiencies (vitamins & mineral deficiencies) [4].

Precautions: The Ketogenic diet is contradicted and not advise to follow by lactating mother, type 2 insulin dependent patient, people suffering from type 1 diabetes, gallstones, fatty-liver, high cholesterol, high triglycerides, pancreatitis. Other precautions

include drink electrolytes loaded drinks when needed like Lemon water, Green Tea. Use enough table salt in order to increase sodium intake for first two weeks as lack of it may cause constipation, headaches, fatigue, heart palpitations.

Clinical Consequence

Ketogenic diet has been controversial from decades. Most of the individual think that these diets are high in fat cause cardiovascular diseases and raise cholesterol and triglycerides level. However in nutrition science most of the studies show that Ketogenic diet is healthy and beneficial.

1. Studies indicates that low carb diet or Ketogenic diet reduces appetite and control hunger cues due to cutting down on carbohydrates and consumption of high fat leads to end up satisfaction with fewer calories intake.
2. Almost without any exception low carb Ketogenic diet leads to more short term weight loss as compared to low fat diet, this is because Ketogenic diet is low carb diet act to get rid of excess water from body, lowers insulin level, fewer calories consumption due to high fat content in diet.
3. Helps in fat loss from abdominal area, excess visceral fat are more prone to accumulate around body organs leads to inflammation and insulin resistance and can cause metabolic dysfunction.
4. Several studies prove that cutting on carbs and consumption low carb diet like ketogenic diet drastically reduces blood glucose and insulin levels, and can reverse type 2 diabetes.
5. Elevated blood pressure or hypertension is a significant risk for many diseases like heart attack, stroke, and kidney failure. Following low carb ketogenic diet significantly reduces blood pressure and prevent from certain diseases.
6. It improves human skin complexion, ketogenic diet increases mitochondrial glutathione (GSH) level, glutathione is the body master antioxidant found in every cells of human body and protect cells from oxidative damage, and glutathione chemical is responsible for skin complexion [5].

Conclusions

Medical practitioner like dietitian, nutritionist and doctors do recommend ketogenic diet to overcome with the pandemic situation of obesity worldwide. Ketogenic diet is beneficial for obese individuals and person suffering from metabolic disorders such as insulin resistance, type 2 diabetes, PCOS, PCOD, high blood pressure, epilepsy, short term and faster weight loss. But on other health point of view this is essential to note that “moderation is

the key” and it should be used with caution for long term to avoid nutritional deficiencies [6-12].

Conflicts of interest

None

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