



Editorial

Ketogenic diets: Boon or bane?

The prevalence of obesity has been rapidly rising over the few decades globally and in India. Obesity also predisposes individuals to type 2 diabetes, hypertension and cardiovascular disease apart from osteoarthritis, sleep apnoea and even some forms of cancer¹. Obese individuals are also prone to psychological issues such as low self-esteem and depression. Medical intervention to manage obesity is very few, and most of them only work with a robust lifestyle intervention programme. This leads to frustration among individuals with obesity, leading them to resort to extreme dietary interventions to obtain quick weight loss. One such extreme dietary intervention which has gained popularity in recent years is the ketogenic diet.

What are ketogenic diets?

Ketogenic diets are characterized by a marked reduction in carbohydrates (usually to <50 g/day) and a relative increase in the proportions of protein and fat - usually extremely high percentages of fat because it is difficult to increase proteins beyond a point².

Types of ketogenic diets

Standard ketogenic diet (SKD): This is a very low-carbohydrate with moderate-protein and high-fat diet. It typically contains 70 per cent fat, 20 per cent protein and only 10 per cent carbohydrates.

Cyclical ketogenic diet (CKD): This diet involves periods of higher-carbohydrates in between the ketogenic diet cycles, for example, five ketogenic days followed by two high-carbohydrate days as a cycle.

Targeted ketogenic diet (TKD): This diet permits adding additional carbohydrates around the periods of the intensive physical workout.

High-protein ketogenic diet (HPKD): This diet includes more protein and the ratio around 60 per cent fat, 35 per cent protein and five per cent carbohydrates but as can be seen, it is still a very high fat diet.

The SKD and HPKD have been used extensively. The cyclical and targeted ketogenic diets are recent additions and mostly used by bodybuilders or athletes. The SKD is the most researched and recommended, and the rest of this article will deal with SKD.

Physiological principles of ketogenic diets

All ketogenic diets contain a very low carbohydrate percentage. After a few days with such drastically reduced carbohydrate consumption (below 50 g/day), glucose reserves become insufficient, both for normal fat oxidation through the supply of oxaloacetate in the Krebs cycle and for the supply of glucose to the central nervous system (CNS). The CNS cannot use fatty acids as a source of nutrition. Hence, after 3-4 days of carbohydrate restriction, the CNS is forced to find an alternative source of energy. This alternative source of energy is ketones. Ketone bodies are produced in the liver and are of two types: acetoacetate and β -hydroxybutyrate. As ketone bodies are produced by breakdown of fats, ketosis is the most reliable indicator of fat loss. Ketosis is a completely physiological mechanism. It was Hans Krebs who first differentiated physiological ketosis from pathological ketoacidosis seen in type 1 diabetes³. In physiological ketosis (which occurs during very-low-calorie ketogenic diets), ketonaemia reaches maximum levels of 7-8 mmol/l (it does not go higher because the CNS efficiently uses these ketones) and also there is no lowering of blood pH. In diabetic ketoacidosis, it can exceed 20 mmol/l with a concomitant lowering of the pH⁴.

Benefits and adverse effects of ketogenic diets

The ketogenic diet was originally developed in 1924 to treat epilepsy⁵, but other, more recently discovered benefits include weight loss and reversal/control of type 2 diabetes⁶. Use of ketogenic diets in weight management has gained tremendous popularity, but it has also generated several

controversies. Some researchers suggest that there are no metabolic advantages with low carbohydrate diets and that weight loss results simply from reduced caloric intake, probably due to the increased satiety effect of protein⁷. However, the majority of *ad libitum* studies⁸ demonstrate that individuals who follow a low-carbohydrate diet lose more weight during the first 3-6 months compared with those who follow more balanced diets⁴.

Besides a positive effect on weight loss, studies have shown that low-carbohydrate ketogenic diets also reduce serum triglycerides dramatically. Elevated serum triglycerides are common among Asian Indians, and this is one of the features of the so-called Asian Indian Phenotype⁹. Reduction in total cholesterol and increase in high-density lipoprotein cholesterol have also been reported. A key enzyme in cholesterol biosynthesis is 3-hydroxy-3-methylglutaryl-CoA reductase, which is activated by insulin. This means that an increase in blood glucose and consequently of insulin levels will lead to increased endogenous cholesterol synthesis. A reduction in dietary carbohydrate will thus have the opposite effect and this, coupled with the additional inhibition by dietary cholesterol and fats on endogenous synthesis, is likely to be the mechanism by which physiological ketosis can improve lipid profiles⁴.

Thus, low-carbohydrate ketogenic diets have been shown to have immense benefits in blood sugar control. There are some reported beneficial effects on cancer and neurological disorders such as Alzheimer's disease and epilepsy¹⁰ although these are not discussed further here as it is beyond the purview of this article.

However, there are also several adverse effects of ketogenic diets. These include muscle cramps, bad breath, changes in bowel habits, keto-flu and loss of energy¹¹. Hence, monitoring individuals on keto-diet closely once or twice a month for blood glucose, ketones cardiac and other parameters is essential.

Should ketogenic diets be recommended?

Indian diets are very high in carbohydrates. The STARCH study has shown that Indians with or without diabetes consume at least 65 per cent calories from carbohydrates¹². The Chennai Urban Rural Epidemiology Study (CURES) has also shown that carbohydrate constitutes the major source of calories in south India¹³. We also know that India has a huge burden of type 2 diabetes¹⁴ and cardiovascular disease¹⁵. Data from the PURE study¹⁶ showed that high carbohydrate intake (more than about 60% of

calories) was associated with an adverse impact on total mortality and non-cardiovascular disease mortality. By contrast, higher fat intake was associated with lower risk of total mortality, non-cardiovascular disease mortality and stroke¹⁶. In contrast, in a recent study on dietary carbohydrate and mortality, Seidelmann *et al*¹⁷ showed that there existed a U-shaped relationship between carbohydrate intake and mortality. Both extremely high (60% and above) and low carbohydrate diets (<30% carbs) were shown to have higher mortality rates. The risk of dying was lowest when the carbohydrate intake was between 50 and 55 per cent. Moreover, mortality rates were lower when the dietary carbohydrates were replaced by plant-based proteins and fats but higher in those who were on animal-based proteins and fats¹⁷.

One of the challenges of low-carbohydrate diets is that these have a lower intake of vegetables, fruits and grains and increased intakes of fat which can be detrimental. Long-term low-carbohydrate diets with increased fat consumption have been hypothesized to stimulate inflammatory pathways, oxidative stress and promote biological ageing¹⁸.

The biggest problem with extreme diets like keto diets is their sustainability. In our experience, people are initially thrilled with the weight loss and the excellent diabetes control they get, after using keto diets. Slowly, however, they get bored with the diet. Furthermore, many feel weak and frustrated and start increasing the carbohydrate intake, and soon they are back to their original weight and diabetes control. Recent studies also suggest that ketogenic diets may, in fact, induce hepatic insulin resistance¹⁹. There are also reports of micronutrient deficiency²⁰ and cardiovascular safety²¹. Hence, many more studies need to be done before these diets are widely recommended.

So what is our final message?

The dictum, 'Moderation is the key' should be used, while following any long-term diet plan. While low-carbohydrate ketogenic diet does, admittedly, show dramatic improvements in the short term, these can increase morbidity and mortality in the long run and are rarely sustainable. Instead of letting the pendulum of nutrients swing on either side, one must be vigilant of the balance and interplay of nutrients, and there should be a representation of all food groups on the plate¹⁸.

For Indians, it appears that it would be most prudent to have a diet with about 50 per cent carbohydrate

(using complex carbs and whole grains such as brown rice or whole wheat) about 20-25 per cent protein (preferably from vegetable proteins such as legumes and pulses) and the remaining 25-30 per cent from healthy fats like monounsaturated fats (e.g. groundnut oil or mustard oil and nuts and seeds) along with plenty of green leafy vegetables. Such a diet may not immediately give dramatic results as far as weight reduction is concerned. However, it will be sustainable in the long term and will be less risky and certainly more healthy and also help prevent non-communicable diseases such as diabetes, cardiovascular disease and certain cancers.

Conflicts of Interest: None.

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