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Review Article

Is it Worth Losing Weight at the Expense of Your Well-Being? An Overview on the Complications of Ketodiet

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ABSTRACT

Ketogenic diet is one of the most viral trends when it comes to weight loss. It consists of high-fat, low-protein, low carbohydrate diet. It is established that this diet has many health benefits especially in decreasing the seizure episodes and in losing weight. Even though it aids the following, it has many short term and long term repercussions. It exhibits short term complications such as nutritional deficiency due to its diet restrictive nature and cardiovascular complications since this diet is rich are fat. Some of the long term complications that are observed with ketogenic diet are decreased bone health, kidney health and risk of cancer occurrence due low carbohydrate intake which restricts milk and other calcium rich products, increased protein intake and lack of fruits and vegetables in the diet. Hence there needs to be more long term research conducted in order for us to know the positive and negative outcomes.

Keywords: Keto- diet, weight loss, Ketogenic, low carbohydrate, long term side effects, short term side effects

INTRODUCTION

The groundwork of ketogenic diet emerged from testimonies that elevated concentrations between ketone bodies, recognized as ketonaemia, reduced seizure [1] resulting in a high-fat, low-protein, low-carbohydrate diet acting as a treatment that is not pharmacological. This diet induces the production of ketone bodies in the liver by means of fat metabolism that imitates a state of hunger without making the body deficient in the calories needed for development and growth. [2-3] Acetoacetate and β-hydroxybutyrate enter and pass through the bloodstream and is absorbed by different bodies including the brain where they are metabolized in the mitochondria to produce energy in the nervous system for cells. [4-7] Acetone, a ketone body, is immediately removed by the lungs and urine. [8,9] Although there is a broad range of literature on the use of ketogenic weight loss diet and epilepsy, this diet has also succeeded in sparking interest as a prospective therapy for other diet-sensitive neurological disorder. [10]

Metabolic activities in Keto- diet

Gluconeogenesis

A very low intake of carbohydrates (<50 g per day) produces an outcome of decreased glucose supply to the liver, muscles and brain, resulting in the deterioration in the amount of glucose warehoused as glycogen. When glucose accessibility is limited, the body will initiate a process called gluconeogenesis.

Gluconeogenesis, which is the endogenous production of glucose and glycolysis or glucose breakdown, always occurs simultaneously and is reciprocal. [11]

Ketogenesis

When gluconeogenesis produces depleted amounts of glucose, the cells that depend on glucose as a fuel begin to use ketone bodies. [12,13] Insulin concentrations in the blood will be small in this situation, significantly decreasing the fat and glucose storage stimulus. This is taken into consideration when endorsing a high-fat diet for weight loss and decrease of diabetes risk variables. This would also lead to fat burning from fat cells, thus increasing the quantity of fatty acids used as fuel. The resulting acetoactic acid is then transformed into beta-hydroxybutyric acid and acetone. Hence ketones are widely regarded as the 'emergency generator that starts when there is a power outage'

Mechanism

There are numerous mechanisms by which ketogenic low-carbon diets may induce weight loss. Diuresis is one of the primary factors for weight loss owing to the depletion of glycogen and ketouria resulting from enhanced renal sodium and water loss. Ketones also suppress appetite. [14-16] It is said that ketogenic diets have a metabolic advantage through the demand of increased gluconeogenesis and up-regulation of mitochondrial uncoupling proteins with a result of wasting of ATP as heat. [17] Other postulated mechanisms include reduced food choice, [14,18] reduced palatability of low-carbohydrate diets, [42] a moderately elevated protein intake quenching effect, [14,15,19] enhanced protein thermogenic effect [20] reduced adipose tissue breakdown as a consequence of decreased insulin levels, [21] and enhanced fatty acid oxidation. [15] Here we can sum up the various factors contributing to weight loss in keto diet

1. Decreased appetite due to higher satiety effect of proteins, [22,23] effects on craving control hormones [24] and the direct appetite-suppressant action of the Ketone bodies. [25]
2. Reduction in lipogenesis and heightened lipolysis. [26,27]
3. Reduction of the respiratory quotient at rest and hence higher metabolic effectiveness in fat consumption. [28,29]
4. Increased gluconeogenesis metabolic costs and protein thermal impact. [30,31]

Other Constructive Effects in Obesity

It could be debated that the ketogenic diet has advantageous effects other than fat and weight loss. In a recent study conducted by Davidson [32] it was suggested that ketones protect the cognitive loss caused by weight gain and obesity. Ketogenic diets are also proven to have positive effects on mood in an overweight subject. [33,34] During the initial days of the diet i.e. first 4 or 5 days the patient complains of exhaustion but this passes quickly and there is a subsequent improvement in the mood. [17,33,34]

A crucial feature of insulin resistance is an impaired ability of muscle cells to adopt circulating glucose and also the ability to hinder hepatic glucose output may be negotiated. Thus, people with insulin resistance have an ultimate issue metabolizing nutritional carbohydrate and will prevent a large percentage of nutritional carbohydrate to the liver where most of it is transformed to fat (i.e., de novo lipogenesis), as opposed to being oxidized for energy in the skeletal muscle. Low carbohydrate diets not only have weight-related impacts but also stronger glycemic control, hemoglobin A1C concentrations improved glycemic control, hemoglobin A1C, lipid markers as well as reduced insulin use or withdrawal and other medicines are other impacts of ketogenic diet apart from weight loss. [35-37]

How reliable is Keto diet?

Studies on the repercussions of low carbohydrate diet is limited in number moreover none of the studies have observed the dieters for more than 12 months. This study period is not sufficient to consider if they are at risk of chronic health problems. Most information on the long-term impacts of ketogenic diets were acquired from the

diet's implementation in the therapy of pediatric epilepsy. It is shown from these pediatric studies that they follow the particular diet pattern for almost a year. Most of them discontinue the diet either due to lack of efficacy or due to the restrictive nature of the food choices.

Short-term

Nutritional adequacy

Low-carbohydrate diets are at greater chance of being nutritionally scanty as they propose restriction of food choices. Low-carbon diets typically have low levels of fiber, thiamine, folate, potassium, calcium, magnesium, iron, and vitamins A, E, and B6. Low diets of carbohydrates contain elevated levels of saturated fat and cholesterol. Protein is obtained from animal sources. [38,39] Participants of ketogenic diet are often recommended a daily intake of multivitamin supplement which will protect them from micronutrient deficiencies. Restrictive low carbohydrate diets do not pose a threat to dietary inadequacy to weight loss goals for short term but during maintenance diets which are usually long term require the balance of micronutrients in order to guarantee optimal health [40]

Cardiovascular health

Several studies have been undertaken evaluating the efficacy of low-carbohydrate weight loss diets in improving the CVD risk in individuals. One of the findings reported in the literature is the ability of low-carbohydrate diets to drastically lower triglyceride levels. [41,42] Samaha et al. [43] discovered in 132 highly obese topics with high incidence of diabetes and metabolic syndrome, greater weight loss and improvements in triglycerides and insulin sensitivity in the low-carbohydrate group in randomized studies evaluating low-carbohydrate diet versus low-fat diet over 6 months. No adverse effects were observed in either group on other serum lipids. The overall amount of weight loss was small (5.8 kg vs. 1.9 kg, low-carbohydrate diet and low-fat diet, respectively. In a follow-up study by the same research group, it was discovered that variations in weight loss with the same cohort of individuals did not differ considerably after 12 months between the two groups (5.1 kg vs. 3.1 kg; low-carbohydrate diet and low-fat diet respectively) but in the low-carbohydrate team, favourable improvements in HDL-cholesterol and triglyceride were retained. A comparable research assessing low-carbohydrate vs. low-fat dietary methods followed 63 obese topics over 12 months ; however, during the course of the research, professional contact was restricted to replicating the strategy most dietitians used in the ' real world '. [44] Low-carbohydrate diet subjects lost more weight at 3 and 6 months, but at 1 year the distinction was not significant. No variations in complete cholesterol, LDL-cholesterol, blood pressure or insulin sensitivity were noted throughout most of the research, while higher improvements in HDL-cholesterol and triglycerides were noted throughout most of the low-carbohydrate group research. In a 24-week research involving 120 obese, relatively healthy people with hyperlipidaemia, a low-carbohydrate diet led in higher weight loss than a low-fat diet (12.9% vs. 6.7%) and enhanced triglyceride and HDL-cholesterol concentrations while LDL-cholesterol concentrations remained stable. [45] Both groups attended twice-monthly group sessions where they received additional dietary advice and suggestions for exercise while the low-carbohydrate group received nutritional supplementation with multivitamins, vital oils (containing fish oil) and herbal supplements. Some of the improvements in triglycerides can be explained by use of omega-3 fish oil supplements. A question that has baffled many is what happens to CVD risk factors weight loss ends and the individual starts an isoenergetic diet. A 6-week research involving 20 ordinary weight and lipidemic males switching from their usual diet to a ketogenic diet (< 50 g carbohydrate d-1) discovered positive improvements in fasting triglycerides (33% decrease), postprandial lipaemia (28% decrease) and fasting serum glucose (34% decrease) with no important

modifications in LDL and HDL cholesterol. [42]

The optimal diet for beneficial long-term reduction in CVD risk is currently unknown. Published studies to date show that low-carbohydrate diets can be used safely for short-term weight loss without adversely influencing CVD risk factors although problems with elevated dropout rates and non-compliance in low-carbohydrate vs. low-fat diet research confuse a conclusive suggestion in favor of the safety of such a dietary strategy.

Long-term health risks

Bone health

A potential impact on bone health of low-carbohydrate diets is a significant issue as these diets were hypothesized to add to the danger of osteoporosis. Observational surveys and controlled trials with kids, young adults and the elderly all support the significant role of calcium consumption in construction and retaining bone mass and decreasing bone loss. [46] Dairy products such as milk and yoghurt which are main sources of calcium are restricted in low carbohydrate diets. In determining long-term danger of fracture and osteoporosis, bone mass is a significant variable. The introduction of dietary procedures that limit calcium consumption may jeopardize maximum bone mass achievement. Low-carbohydrate diet trials have not yet been long enough to assess long-term bone loss. Higher dietary protein intakes on a low-carbohydrate diet were suggested to affect calcium and bone metabolism through enhanced calciuria. [47] Low-carbohydrate diets have the ability to create a subclinical chronic metabolic acidosis (through the existence of ketone bodies in the blood) that can then encourage bone calcium mobilization. [48] Barzel and Massey [47] proposed that diets with the ability to boost renal acid load lead to calciuria that may adversely affect the bone unless they are buffered with alkali-rich ingredients such as fruits and vegetables. However, recent studies seem to contradict this hypothesis with a large-scale epidemiological research of over 900 adolescents demonstrating no adverse impact on bone mineral density of animal protein intake. [49] The above research indicates a beneficial advantage for bone health with greater intakes of protein as would typically be seen on a low-carbohydrate diet - at least in an elderly population. The current proof indicates that a low-carbohydrate diet does not have an unfavorable immediate effect on bone health, although the nutritional limitation of calcium from reduced consumption of dairy products should be tackled by including extra sources of calcium food or calcium supplements.

Kidney health

Because of its nature, a low-carbohydrate diet is a diet greater in protein and fat than a regular diet. One issue posed is whether a diet that is substantially greater in protein than the usual nutritional consumption can influence the function of the kidney. Previous low-carbohydrate diet trials were not of adequate length to assess their renal function potential. Recent observational data from 1624 participants in the Nurses' Health Study have linked diets high in protein with reduced kidney function over time. [50] In this study, women who began the study with mildly decreased kidney function showed a worsening with increasing protein intake. Those women with healthy kidney function at the outset showed no signs of decline. The limitations of the study were that dietary protein intake was only assessed at two time points and participants were not randomized to follow specific diets so other dietary or lifestyle factors could be involved. One prospective study conducted over 6 months found that moderate changes in dietary protein intake (25% of energy vs. 12%) caused adaptive changes in renal size and function without any measurable adverse effects suggesting that individuals without pre-existing impaired renal function can likely endure a higher protein intake of a low-carbohydrate diet. [51] Future studies involving low-carbohydrate diets need to assess kidney function in order to determine whether

populations likely to follow low-carbohydrate diets for long-term weight loss and maintenance are at risk of accelerating kidney damage. A low-carbohydrate would not be recommended for people with diagnosed pre-existing impaired kidney function.

Cancer risk

There is powerful proof of a protective impact of fruit and vegetables in nearly all significant cancers of Western society, including colorectal, breast, pancreatic, pulmonary, stomach, esophageal and bladder cancers. [52] Fruits and vegetables contain a wide range of compounds involved in cancer defense. Substances such as antioxidants, fiber, isothiocyanates (in cruciferous vegetables), allyl sulphides (in onions and garlic), flavonoids and phenols were all connected together to supplement the body's cancer protection mechanism. The nature of a low-carbohydrate diet is low in fruits, vegetables (if starchy vegetables are not properly replaced with other kinds of low-carbohydrate vegetables) and grains possibly place an person at an enhanced danger of cancer if the diet is followed on a long-term basis. Obesity likely has an independent effect on cancer risk with epidemiological evidence pointing to increased incidence of colon, breast (in post-menopausal women), endometrium, kidney, esophagus, gastric, pancreas and gallbladder cancers in overweight and obese individuals. [53] The issue that remains unanswered is what danger a individual will encounter following a long-term isoenergetic eating plan that encourages a decrease in the general consumption of fruit, grains and some vegetables. While there is definitely no proof that a low-carbohydrate diet increases cancer risk, there is also no proof that a low-carbohydrate diet does not improve cancer risk.

CONCLUSION

Over the past few years, ketogenic low-carbohydrate diets have become more popular, but the degree of carbohydrate restriction needed to accomplish ketosis remains uncertain. Studies have generally shown higher weight loss with keto-diets at 3-6 months but this distinction is no longer evident at 12 months. More long-term Keto diet studies are needed to exploit its potential and study its long-term complications.

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