

A review on losing weight by Ketogenic Diet with suggested improvements for healthier results

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The ketogenic diet has gained popularity as a method of weight and health management. This diet leads one's body to produce ketone bodies under a physiological state called ketosis. The ketone bodies are derived from lipids and thus, people on this diet must primarily consume fat-rich foods and only a picayune amount of carbohydrates, or avoid them altogether. Multiple studies have shown that this diet, initially designed to treat epilepsy patients, promotes fat loss amidst other side benefits, such as reduced risks of cardiovascular diseases. Nevertheless, there have also been studies impugning Keto's efficacy and suggesting its potential harm to heart arteries due to the high consumption of fats. Ultimately, it remains unclear whether or not intentionally triggering ketosis is an advisable way of reducing weight. This paper reviews the background of the ketogenic diet, its mechanism of action and effects in the body, its role in sport, commercial products related to the diet, and disputed ethical issues related to the diet, delivering some clarity whether or not it is a recommended diet to adopt also discussed. In addition, personal perspectives on ketogenic diet improvements through synthetic biology, as well as better ways to maintain healthy diets will be further discussed in this paper.

Keywords: ketogenic diet, low-carb diet, ketone powder, high-fat diet, ketogenic lipolysis, weight loss

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Watch a video introduction by the authors at <https://youtu.be/6g8AhYu9QD4>

Introduction

Nominally suggestive, the ketogenic diet is a diet that causes its adherents to produce what is called ketones or ketone bodies (Masood et al., 2020). Normally, the human body would dominantly depend upon glucose via glycolysis and traditional pathways of cellular respiration to furnish its myriad cells with energy (Nakrani et al., 2020). Under such circumstances, the body receives its glucose from starches, disaccharides, and other large molecule carbohydrates that it digests. However, in the absence of these carbohydrates, a physiological state called "ketosis" would be reached, and in lieu of glucose, ketone bodies like beta-hydroxybutyrate and acetoacetate that originated from lipid metabolism would be

relied upon for energy, and thus, the body's fat deposit would dwindle (Cahill, 1973). This can either happen during starvation (Grey et al., 1975) or be forced by one's choice of ingestion. The ketogenic diet colloquially called the keto diet, attains ketosis via the latter means by placing a rigorous limit on one's carbohydrate consumption to only 10% of their total caloric intake (O'Connor, 2019). However, because proteins can be broken down to produce glucose via gluconeogenesis pathways without carbohydrate consumption (Westman et al., 2003), protein intake is also limited to 20% of total caloric intake (O'Connor, 2019).

Initially devised to treat epilepsy-stricken patients (Wheless, 2008), an exponentially increasing number of people nowadays are gravitating towards this diet as

an apparatus to achieve fat loss and acquire desirable physiques (Pollock Communications, 2019). This meteoric ascendancy of the diet can be reflected upon by the legion keto commodities such as “keto powder” and artificial sweeteners claimed to be kosher substitutes for sugar, which is prohibited under the diet, having been contrived and marketed. One rationale behind this phenomenon is that it is purported and supported by multiple studies to promote expeditious fat loss amidst other beneficial corollaries like increased athletic performances and reduced risks of cardiovascular diseases (Kosinski & Jornayvaz, 2017). Indeed, clinical trials corroborated this predicate, indicating that ketogenic subjects were inclined to lose more fat and weight than their counterparts who espoused the traditional low-fat diet (Ting, et al., 2018; Masood, et al., 2020; Dashti, et al., 2004). Nevertheless, there has also been evidence negating the buoyant claims of the diet’s boons (Joshi, et al., 2019). Some studies even claimed that embarking on the Draconian diet can have damaging consequences, including nutrient deficiencies, kidney stones, and even diabetes (Helms, 2019; Harvard Medical School, 2020; Hu et al., 2012; Choi et al., 2010). Moreover, there were also studies impeaching the aforementioned keto-related merchandise, suggesting they are either of no avail or potentially insalubrious (Valenzuela et al., 2020; Neudorf et al., 2019). Apparently misconception one might have about exploiting keto for weight loss.

Definition

A keto or ketogenic diet is a low-carb, adequate protein and rich fat diet that offers numerous health benefits such as weight loss, reduced appetite, and a consistent energy supply. The diet causes the body to produce small fuel molecules called ketones, a substitute source of energy for the body that can be used when glucose is in low supply. The reduction in carbohydrate intake induces a metabolic state called ketosis, where the whole body turns burning fat as the primary energy source. As the insulin levels become drastically low, the fat burning can surge (Eenfeldt & Scher, 2021).

Types of Ketogenic Diet

There are four diverse types of the ketogenic diet: (Dhamija et al., 2013):

1. The traditional, classic ketogenic diet involves a specific ratio by weight of carbohydrate and protein combined to fat. The diet can be attained by avoiding a high-carbohydrate diet and increasing the intake of fat-rich foods.
2. The medium-chain triglyceride (MCT) ketogenic diet uses MCT oil to supply approximately half the calo-

ries. Since the diet requires less total fat, the food consumed can be higher in carbohydrates and protein, making for a larger diversity of food options.

3. The modified Atkins diet (MAD) actively promotes fat consumption and provides a carbohydrate intake of 10- 20g per day. The calorie is not limited, and the diet can be roughly measured.
4. The low glycemic index treatment (LGIT) limits the carbohydrate intake to 40-60g a day and includes only foods with a glycemic index of less than 50.

History

In 1911, two doctors, Gulep and Marie, reported the first contemporary use of starvation to cure epilepsy, although no further data were given. Early in the twentieth century, a report on a patient of an osteopathic physician, Dr. Hugh W. Conklin, of Battle Creek, Michigan, and another involving Bernarr Macfadden were documented in the United States (Wheless, 2004). Macfadden, a founder of a magazine on health, bodybuilding, and fitness called Physical Culture, became widely known, and fasting method was applied to treat various illnesses, especially epilepsy, by his assistant, Dr. Conklin. A word about Dr. Conklin’s successful fasting study spread rapidly and became incorporated into the Montreal Neurological Institute’s textbook on epilepsy by Penfield and Erickson (Wheless, 2008).

In 1921, Rollin Woodyatt, an endocrinologist, observed that starvation or diet with low amounts of carbohydrate and high serving of fat results in the production of acetone, β -hydroxybutyrate, and acetoacetate by the liver. Dr. Wilder at the Mayo Clinic called this the “ketogenic diet,” suggesting that the diet can be sustained for prolonged periods and should be equally effective as fasting. The KD then became a very common approach to treat epilepsy during the 1920s and 1930s. Since then, there have been several research and studies on a diet, and thus a medium-chain triglyceride oil diet was developed by Dr. Peter Huttenlocher to make the KD more appetizing. However, the diet’s popularity gradually dwindled as novel medications to treat epilepsy came into existence. Consequently, fewer children were prescribed the diet, and the number of trained dietitians specializing in it subsided (Wheless, 2008).

How the Ketogenic Diet Became a Trend

The ketogenic diet became a widespread method for individuals who aim to lose weight. The popularity of the ketogenic diet was triggered after the publication of a study by scientists at the Gladstone Institute, a San

Francisco-based research center, in January 2013. Tim Ferriss, Silicon Valley-based podcaster and author of *'The 4-Hour Work Week'*, attempted the diet and reported promising outcomes on fat loss among non-athletes, receiving large amounts of attention from his one million monthly followers. The number of those intrigued by ketogenic diet has only continued to burgeon with the participation of other health influencers in the ensuing period. *The Joe Rogan Experience* was then launched as a result of the Ferriss podcast, and Rogan's 30 million monthly listeners were introduced to the ketogenic diet. The diet became a popular trend on social media because of its ability to expeditiously deliver and the mushrooming of outstanding before-and-after images of its disciples on Instagram (Easter, 2019).

False Beliefs

There are numerous statements related to the ketogenic diet, some of which are true; however, some are false. These are some of the beliefs about going keto that has been debunked.

1. **Ketoacidosis may occur as a result of nutritional ketosis.** Ketoacidosis is a serious condition that mainly affects people with type 1 diabetes or insulin-dependent type 2 diabetes, though it is rare in healthy individuals with a completely functional pancreas. However, dehydration, illness, and possibly pregnancy are the rare exceptions that ketoacidosis can occur on the ketogenic diet (Metagenics, 2018).
2. **Vegetarians and vegans are unable to follow a ketogenic diet.** There are varieties of plant-based fat sources such as avocados, nuts and seeds, and olives; that are great options for a ketogenic diet. Eggs and dairy can also be included in the diet for vegetarian individuals. In addition, there are several low-carbohydrate vegetables, such as lettuces, celery, cucumber, and zucchini, that should be included in the diet (Metagenics, 2018).
3. **Carbs are indispensable to humans.** There are two alternative sources of glucose conservation. The first one is gluconeogenesis, that converted amino acids into the glucose. And the glycerol backbone of triglycerides serves as the second source of glucose (Metagenics, 2018).
4. **The low-carb diet and ketogenic diet are the same.** The main difference between both diets are carbohydrate and protein intake. On a low-carb diet, 50-150 grams of carbohydrates can be consumed per day, while on the keto diet, carb intake per day should be less than 50 grams. Protein consumption can be elevated on low-carb diets; however on keto diets, protein intake should be modest (Preiato, 2019).

5. **A ketogenic diet causes cardiovascular diseases.** According to a study, the improvement of some cardiovascular risk factors, such as obesity, type 2 diabetes, and HDL cholesterol levels, can be correlated with ketogenic diet. The diet has also been shown to enhance insulin sensitivity in humans (Kosinski & Jornayvaz, 2017). Nonetheless, the consumption of saturated fat should be restricted since it increases the risk of developing atherosclerosis.
6. **Any type of fat can be consumed during keto.** Limiting saturated fats, such as bacon and ham, and replacing them with healthy unsaturated fats, such as avocados, olive oil, and flaxseed, as well as nuts in moderation, is the healthiest way to consume fats (Migala & Kennedy, 2019).

Mechanism of Action

The human body depends on carbohydrates for energy whether from dietary intake or from glycogen breakdown. Both are subject to the physiological control of the antagonistic hormones insulin and glucagon secreted to lower blood sugar by instigating an anabolic state and promoting cellular glucose uptake and increase blood sugar by ushering the body into a catabolic state and stimulating glycogen breakdown, respectively (Ojha et al., 2019). Traditionally, blood sugar would be raised after a carbohydrate-rich meal is ingested and as its carbohydrate constituents are digested into glucose, readied for absorption and metabolism (Bertelsen et al., 1993). However, for adherents of the ketogenic diet consuming only a diminutive amount of carbs throughout their regimen, blood sugar would marginally increase at a maximum, which is inadequate to trigger the level of insulin release observed in those following regular diets. Insulin levels in these particular people thus plateau whilst glucagon starts to abound, precipitating catabolism (Masood et al., 2020). At first, the stored glycogen would be converted into glucose to substitute what would normally derive from a meal, but as soon as glycogen is depleted, the body would enter ketosis, and an alternative route of ketogenesis and gluconeogenesis would be adopted to provide dearly needed energy.

Ketosis and ketogenesis are the hallmarks and the ultimate aim of the keto diet, but as remotely similar as the two names sound, they embody two different contexts. The state of ketosis is one in which the body chiefly relies on ketone bodies like beta-hydroxybutyrate and acetoacetate for energy, both of which are produced from lipids in a process called ketogenesis (Cahill, 1973). In glucose deprived states, these ketone bodies step in and substitute the monosaccharide as the body's primary fuel source, which turns out to be fruitful for lipolysis. Not only do the ketone bodies originate from lipid metabolism, a process that chisels away the body's fat

deposit, the aforementioned paucity of insulin and the subsequent catabolic state also translate into an inferior ability at anabolic activities, one of which is indubitably fat storage (Masood et al., 2020).

In the meantime, as a last attempt to furnish the body with glucose, gluconeogenic pathways would also be undertaken. In these pathways, the liver metabolises substances like glycerol and amino acids to produce glucose (Oleksyszyn, 2011). Since excessive glucose levels can shift the body's metabolism onto its conventional carbohydrate-processing track, the excess of proteins, the primary source of amino acids, can potentially disrupt ketosis (Veldhorst et al., 2009). Therefore, proteins are another macronutrient subject to the limitation in keto (O'Connor, 2019).

Incidentally, the ketogenic diet is also shown to suppress appetite by influencing the hormone axes responsible for hunger. Usually, after a period of weight loss, the body is inclined to instigate a chain of compensatory mechanisms that result in a surge in hunger and a plummet in energy expenditure, translating into weight regain if left unfettered (Leibel & Hirsch, 1984). This represents a problem of oscillating diets inherent to nonketotic dieters. However, in those opting for ketosis, such a predicament is nary a case. It is widely purported that ketogenic dieters experience a drop in appetite and past studies like Yancy et al. (2004) and Boden et al. (2005) also found extemporaneous keto dieters to lower their caloric intake instantaneously unwittingly. A supposed reason for this phenomenon is the drop in ghrelin, a peptide produced by the stomach to promote hunger, which is positively monitored in the study of Sumithran et al. (2013). Thio et al. (2006) also discovered an increase in the level of leptin, a hormone produced by adipose tissue as an antagonistic agent to ghrelin to regulate appetite, in mice fed with ketogenic diet. Moreover, ketone bodies are proven to provide more ATPs than glucose when metabolized (Masood et al., 2020). The extra ATPs from beta-hydroxybutyrate and acetoacetate and the ketosis-induced manipulation of hunger-regulating hormones are influential in enabling ketogenic diet followers to lose weight without "yo-yoing", a cycle of losing and regaining weights over and over.

Effects of Ketogenic Diet

Physical Effects

Benefits

1. Carbohydrate is one factor that leads to weight gain, so eating less carbohydrate can reduce calories. Low-carb diets rid excess water from the body, lowering insulin levels (Gunnars, 2018) and leading to rapid

weight loss in the first week or two. This means that low carbohydrate diets lead to more short-term weight loss than low-fat diets.

2. A large percentage of the fat loss due to a low carbohydrate diet is harmful abdominal fat and causes serious metabolic problems.
3. Triglycerides, which are fat molecules in bloodstream, lead to heart disease. When people cut carbohydrates, triglycerides tend to drop dramatically in the blood.
4. High-density lipoprotein (HDL) is often called the "good" cholesterol. HDL is related to low-carb diets because to increase good cholesterol is to eat fat and low-carb diets include lots of fat.
5. Ketogenic diets can be beneficial for people with diabetes and insulin resistance, affecting millions of people worldwide.
6. Cutting carbohydrates can low blood pressure, which leads to many diseases.
7. Metabolic syndrome is associated with diabetes and heart disease, so reducing these disease factors by low carb diets will reduce the chance of metabolic syndrome.
8. "Bad" cholesterol or LDL leads to heart attacks can be reduced by having low-carb diets.
9. Ketogenic diets can treat epilepsy which is a brain disorder in children.

Drawbacks

1. Ketogenic diets can be effective when used in a short period followed by adopting healthier eating habits.
2. It is hard to sustain because of the stringent food restrictions.
3. It will cause nutrients deficiency because of the restrictions. For instance, vitamins, minerals, and fibers.
4. Those who take a ketogenic diet may feel foggy and tired. These symptoms have been dubbed "the keto flu." The cause was lacking fibers.
5. Lacking fibers can cause diarrhea.
6. People who use ketogenic diets should limit saturated fats intake to 5 to 6 percent. If not, the fats will

increase in the blood.

7. Some people also experience dehydration on the keto diet because they are eradicating glycogen, which holds water, from their bloodstream.
8. Restriction from ketogenic diets can lead to bingeing, which often leads to guilt, leading back to restriction in a continuous cycle.
9. Diabetes patients (both type 1 and 2) should not follow the keto diet unless they have doctor's permission and close supervision. That is because, for people with diabetes, ketosis can trigger a dangerous condition called ketoacidosis.

Mental Effects

Firstly, fatty acid oxidation greatly results in the elevation of ketones. Specific polyunsaturated fatty acids (PUFAs) possibly regulate neuronal membrane excitability themselves by blocking voltage-gated sodium and calcium channels. Together with reducing inflammation through activation of peroxisome proliferator-activated receptors, or inducing expression of mitochondrial uncoupling proteins which reduce reactive oxygen species (ROS) production. By raising ATP levels and reducing reactive ROS production, a ketogenic diet has been proven to stimulate mitochondrial biogenesis, causing stabilized synaptic function.

Further, the decrease in glycolytic flux is considered the second major feature of the ketogenic diet. The rationale behind this is that it is an essential feature of calorie restriction, which has been shown to suppress seizures, as well as prolong the lifespan of primates and other species. While the link between calorie restriction and ketogenic diet mechanisms remains controversial, it is clear that both treatments result in a reduction of blood glucose, likely involving reduced glycolytic flux.

Apart from being a treatment for epilepsy, the ketogenic diet has shown to have some positive effects on Alzheimer patients, regarding neuronal excitability. It also showed similar feedback on the neurological conditions, namely Parkinson disease, amyotrophic lateral sclerosis, stroke, brain trauma, and depression.

Socioeconomic Effects

As the considerable number of individuals with obesity escalates, weight management programs, including Ketogenic diets, are progressively demanded in order to diminish risks of chronic diseases, such as cardiovascular diseases, diabetes, and high blood pressure. Not only helping with weight loss, but several studies have also revealed that a ketogenic diet can treat numerous

diseases, such as obesity, epilepsy, brain injuries, Alzheimer's disease, Parkinson's disease, polycystic ovary syndrome, cancer, and cardiovascular diseases. These properties notably intensify the demand for ketogenic diets more (Grand View Research, 2020). This immensely impacts society and the economy.

Focusing on the impact on society, ketogenic diets have affected consumer's buying habits and the environment. ketogenic diets are socially supported mainly through social media, which significantly influences consumers' buying habits. Examples of these are that the increasing number of consumers are sharing ketogenic food ordering tips at restaurants and posting several articles about keto-friendly foodservice locations. Some offer tips for following a ketogenic eating plan or recipes for ketogenic dishes (Cassity, 2020). However, ketogenic diets can harm the environment or are not sustainable for the agricultural industry. Because of the high protein required for the diet, many choose meat products as their method. However, meat production can leave an enormous carbon footprint. Moreover, 43 kilograms of greenhouse gas emissions are released for every one kilogram of beef produced (Deol, 2019).

Continuing with the influence on the economy, the rise in the consumer's demand, manufacturers are adopting various marketing strategies, such as new product launches, collaborations, and expansion of distribution channels (Grand View Research, 2020).

Perceptibly, the popularity of ketogenic is affecting product launches. Numerous companies are putting more dedication towards ketogenic products and are increasingly releasing keto-friendly and low-carb food options to an immense amount of distribution channels (Roberts, 2020). A study also demonstrated that the meal replacement product category grew by 12% from 2012 to 2017. Simultaneously, the supplement nutrition drink category grew by 23% (Wiener-Bronner, 2018). Moreover, to enhance consumer's convenience, snack products, which contain nutrients required to complete the diet, are gaining more attention by manufacturers (Grand View Research, 2020).

Another method being progressively adopted is collaborations. As the ketogenic diet food market is highly competitive and comprises regional and international competitors, in order to dominate the ketogenic food market, numerous companies seek collaborations or partnerships with other companies. This not only expands their product portfolio, but it also increases their geographical presence and customer base (Mordor Intelligence, N/A). On the other hand, the agricultural economy is suffering from ketogenic diets. As the main purpose of the ketogenic diet is to alter the system's fuel from carbohydrates to fats, this means the agricultural production of

grains and wheat have to be reduced. In addition, grains are a crucial part of the process of crop rotation and are less expensive compared to corn-soybean rotation (Tolin, 2018).

Supplementary Courses of Action

As previously mentioned, low-carb diets would be attained to enter the state of ketosis, leading to raise blood ketone and weight loss accordingly. However, to achieve this fully and most effectively, some might suppose it takes much patience and effort as consumption management and limited amounts of delicious diets taken are essential. For this reason, suggestive supplements that aid generate ketone bodies, called exogenous ketone supplements, have become an alternative for those not wanting to manage their carbohydrate intake (Norton, 2020). In this paper, two exogenous ketones are exemplified, as well as discussed their courses of action: ketone powder and kosher artificial sweeteners.

Ketone powder: According to many studies, exogenous ketones are chemically synthesized due to insufficient concentrations of natural ketones in daily food to cause useful actions in the human's body (Phinney & Volek, 2019). Nevertheless, it is believed that ketone powder on shelves seems to work as effectively as endogenous ketone bodies do. Still it also varies from natural types since they own different components – that is – exogenous ketones are derived from D-isomers and L-isomers, but the endogenously produced has only the D-forms. More importantly, the D-isomers are proved to generate more metabolism than the other form can; hence, it is still under investigation; whether the synthetic ketone should be used for generating ketosis or not. Below we state several potential courses of action for intaking ketone powder.

- When taking ketone powder or pills, or even creams in coffee, it takes only a few minutes to commence the ketosis state by tricking one's body to realize that it deprives carbohydrates and generating ketosis. This action lasts for a couple of hours (Korn, 2020), while natural ketosis takes 4-7 days.
- These supplements can create weight loss within a very short period; however, some suggest they only experience unremarkable results.
- The more benefits of taking ketone supplements lie as follows: increasing energy, generating a good mood, improving sports performance, causing appetite suppression, and aiding metabolism to return to ketosis after consuming carbs (Eenfeldt & Scher, 2021).

However, there is still a lack of evidence; whether ketone supplements work permanently and safely to human

bodies with no harmful side effects since this has been just introduced to consumers just in the past few years. Further, many studies have reported contradictory results indicating positive effects of ketone salt intake - that is, to accelerate fat oxidation, but also to show negative results- that is to impair highly-intense exercise performance. For this reason, further research would be conducted to test the actual efficiency of these dietary supplements.

Kosher artificial sweeteners: ugar is considered one of the sources which can supply carbs for the human's body. Consequently, people who are challenging themselves in this competitive action might seek sugar substitutes or artificial sweeteners to reduce carbohydrate intake daily. It is believed that these artificial sweeteners can give zero or least calories but more 300% sweetness than sugar does. However, there are some effects on a human's body when intaking these substitutes, such as aspartame as follows.

- It appears that these sweeteners affect microbiomes in humans, which is the gathering of microorganisms living in and supporting all functions in a body- that is, they could develop glucose intolerance and metabolic imbalance, leading to some chronic diseases and obesity ultimately.
- There has been proof indicating brain malfunctions after taking artificial sweeteners, including learning problems, seizures, migraines, irritability, headaches, depression, and insomnia.

Mentioning beneficial artificial sweeteners for ketosis, there are still some which are considered and scientifically proved to be effective for use. The list of those is discussed below.

- First, it is sucralose, which does not help maintain metabolism in the body. To be specific, it only passes through the body and is released out undigested, giving no calories or carbs to the body. Sucralose is mostly used in drinks, oatmeal food, and yogurt, and it is 600 times sweeter than table sugar (Link, 2018).
- Second, allulose is recommended due to its low-calorie content. It has 70% sweetness of table sugar and is highly found in salad dressings, fillings, and sauces.
- Last, saccharin is also suggestive for baking and cooking as it has heat stability and does not provide calories or raise blood sugar. This artificial sweetener can be 300 times sweeter than usual sugar. The only benefit is to be replaced with table sugar, not supporting any other health advantages (Baum, 2020).

Overall, ketone bodies can be encouraged by intaking supplementary substances such as ketone powder and by selecting useful artificial sweeteners to stay ketosis. However, some disadvantages if using these supplements are also proved and resulted, hence, it is recommended to do adequate research and follow what the experts suggest and instruct on working on ketone bodies.

Ethical issues

It is still debatable whether a ketogenic diet is sustainable or not. Because the diet is becoming popular, many different views are available. To illustrate one opinion, Dr. David Katz, who is the founding director of Yale University Prevention Research Center, mentioned that the diet is "a type of a fad diet that should not be praised a day for." The reason behind his disagreement is that keto restricts the balance of other food groups. In other words, it prioritized a group over the other such as limiting any added sugar or carbohydrates of the product. The body may be missing some essential vitamins from fruits with sugars or proteins from legumes and beans. Hence, ketogenic contradicts the principle of intaking five food groups (LaMotte, 2020).

With some opposition to the ketogenic diet and dismissing it as a fad comes a proponent of the diet. The Ketogenic diet has been proven more effective in the treatment of diabetes and obesity than other low-fat diets. In fact, throughout the time that the general public has been advised by their healthcare professionals to follow a diet that is decreased in saturated fat, the rate of diabetes and obesity has not improved. Not only did the rate increase, but it also rose remarkably. For patients with type 2 diabetes, the carbohydrate restriction of the ketogenic diet has been shown to reduce blood glucose and insulin and the need for antihyperglycemic medication. For patients who are obese, a low carbohydrate diet does not promote fat storage, increase hunger, and low energy expenditure as a low-fat diet would do. In addition, when a body is subjected to chronic ketosis, there are some metabolic benefits for patients with cancer, neurodegenerative conditions and other diseases that are associated with insulin resistance (Ludwig, 2020).

After considering both proponents and oppositions of the ketogenic diet, an ethical issue arises. It is a known fact that ketogenic diets are prevalently used to treat epilepsy, especially in children. A study shows that it has been used clinically for over eighty years and has been proven effective for the treatment of epilepsy (Thiele, 2003). However, for children as young as three years old or three weeks old in the study, an appropriate ketogenic diet must be formulated so that the body of these growing children does not become deficient in nutrients. A prolonged ketogenic diet may be beneficial to their epi-

leptic seizures but may be harmful to the general growth and development of the child (Kim, 2019).

One concern is raised by Wellness Dietitian Mary Condon; for patients with diabetes who are attempting to go on ketogenic diets to reduce their blood glucose and insulin, eating excessive amounts of saturated fats may help with diabetes but may increase the risk of heart disease. If the ketogenic diet is not done properly with heart-healthy fat sources, it may be dangerous for the heart (Helms, 2019).

Ketogenic diet and sports

The ketogenic diet is not only adopted by people wanting to lose weight; the same principle of having low-carb and high-fat intake is purposely used in diverse athletes to enhance their performances. Athletes in general utilize their bodies intensively, so it is intriguing to achieve insights into how ketogenic diet affects their physiology. Studies in endurance athletes, CrossFit Trainees and off-road cyclists reported that ketogenic protocol led to a better body status in terms of favorable changes in body mass, body composition as well as a healthier blood parameter (Zajac et al, 2014; Zinn et al, 2017; Kephart et al, 2018). Interestingly, male athletes were found more efficient in fat utilization under a ketogenic diet than female athletes (Durklac-Michalski et al, 2019).

However, when considering the outcome performance, the ketogenic diet was not significantly superior to the conventional carbohydrate diet. For endurance sports, studies stated that athletes undergoing a ketogenic diet reported tiredness, feeling loss of power and impairment in their performances (Zinn et al, 2017; Wroble et al, 2019; Burke et al, 2020). These findings could simply be explained by the fact that a higher oxygen is required for fat to liberate energy (Burke et al, 2020); therefore, it takes a shorter time for those with low-carb and high-fat consumption to re-achexhaustion. Nevertheless, some positive qualities, such as improved recovery was mentioned (Zinn et al, 2017). One recent study suggested a long-term high fat diet might be advantageous for the preparatory season when the training was less intense (Zajac et al, 2014). For anaerobic exercises, the same phenomenon was also found. Research showed athletes going through a ketogenic diet resulted in either no change or lower peak power, less total distance ran and a reduction in total work capacity (Wroble et al, 2019; Kephart et al, 2018).

In brief, a ketogenic diet was beneficial to most athletes' metabolism in the same way as ordinary people. However, it is not the best choice for professionals who expect to achieve the best performance.

Future possible solution

The ketogenic diet is an abrupt way to achieve weight loss and reduced blood sugar. However, such weight-loss effects could be ephemeral, and adherence to the diet could actually entail weight rebound. Moreover, many symptoms such as low blood pressure, kidney stones, constipation, nutrient deficiencies and an increased risk of heart disease can be induced by the ketogenic diet. In the same way, It could also cultivate eating disorders, which is unsafe for those with any conditions involving their pancreas, liver, thyroid or gallbladder (Helms, 2019). Because of this, the diet is likely unsustainable in the long run. Instead, there are multiple alternatives to maintain health and accomplish weight loss. Diet regimens incorporating moderate fresh fruits and vegetables, whole grains, and low-fat dairy can provide long term weight loss, for instance (Helms, 2019). They could also enhance mood and minimize disease risks. However, careful strategization and consistent behaviors are also requisite for any of such goals to meet reality. These include mindful eating, avoiding unhealthy snacks, and managing expectations, as well as experimenting to identify the type of regimen that is practicable and effective in the long run, which is one of the key contributors to successful dieting (Spritzler, 2019).

Nevertheless, dieting and exercising are a challenging task that slowly translates into result. This explains why researchers have excogitate many interventions that can speed up the progress or generate the same outcome with less effort. The recent research papers leads to future possible solutions of healthy dieting that can help humans lose weight and stay healthy simultaneously. Researchers found that, when injected with a compound called morpholino, subjects' muscles burned more energy without any increase activity intensity. An experimental result of the method that exemplifies the newfound means to hijack the body's natural mechanisms for more convenient weight loss (Norman, 2018).

Moreover, there is certain medical technologies that can supplant the ketogenic diet in one's quest for fat loss. While they are accompanied by a decent amount of risks, they also promise results at a lower nonfinancial cost (i.e. efforts and time). The gastric sleeve diet, which removes part of the stomach and joins the remaining portion together to make a new banana-sized stomach or sleeve, is a remarkable example. The less voluminous stomach translates into the less dietary intake, which predisposes the body to burn fat (Dansinger, 2020). As time progresses, the diet will potentially shift toward helping one acquire healthy eating habits, which can enable a weight-loss trajectory curtailed at maintainable levels to continue to lose weight and, eventually, maintain a healthy weight for life (Butler, 2019). Another

example of weight-loss-inducing medical technology is Roux-en-Y Gastric Bypass, which is one of the most common brands of weight-loss surgery. This method connects the stomach to the jejunum, creating a fast track for ingested food boli that circumvents the duodenum, which is active in the digestion and assimilation of nutrient molecules. This method, along with gastric bypass surgery in general, is associated with low risks and a low accidental death rate (Ambardekar, 2020). However, notwithstanding the fact that these non-dietary methods are more convenient and devoid of the risks potentially imposed by the ketogenic diet, a more thorough research endeavor is still required.

Future applications

For future applications, the ketogenic diet has more positive effects than the treatment of epilepsy. Ketone bodies are beneficial in forestalling the growth of cancer cells due to the fact that ketone bodies cannot be metabolized by cancer cells. When the body uses ketone bodies as its energy resource, energy capability improves essentially, and weight loss occurs. The body begins to break down fat reserves and begins to devour fatty acid deposits in the liver. The browning of adipose fat cells, which produce more heat in the body, promotes the usage of ketone bodies as energy (Somayajulu, 2017). Therefore, researchers need to study intensively the diet to investigate the best means to maintain health and perhaps procure other side benefits like treatment for certain medical conditions.

Personal Opinion

Our group believes that a ketogenic diet, if formulated correctly and appropriately, is a helpful tool that provides the body with a short term benefit for healthy weight-loss. However, ketogenic reduces the amount of other important nutrients such as carbohydrates, so the nutrients and essential vitamins and minerals might not be enough for overall human health in the long run (LaMotte,2020). Therefore, the long term consequences may be negative for lots of people, especially children and teenagers. In fact, they should avoid any type of diet, not just ketogenic, so that their bodies have enough nutrients to develop and grow. Instead, they should consider including exercise in their daily routine, so that a more sustainable way of staying healthy and losing weight is formed. If the goal is to lose weight, study all the side effects before choosing the right diet. Try matching the different types of diets with the daily lifestyle, activities and eating behavior, so the diet remains effective and healthy. This may include switching between different diet styles in order to maintain nutritional balance because being healthy should be the ultimate goal.

Next Steps

Since ketogenic diets are not foolproof, there is a necessity for those capable of providing accurate information for the public and dispel whatever romanticism there might exist as a method to achieve weight loss and an aesthetic physique. Additionally, efforts in their trials and modifications—perhaps the formulation of a novel diet plan that tentatively integrates keto's regimen with that of any other type of diets available, which may deliver knowledge about synergies between them that are conducive to both the ultimate goal of fat catabolism and the side benefits to health—are worth the consideration and undertaking. For example, the "Paleo" diet, which prescribes its followers to exclude foods that would have been foreign to the antediluvian human civilization (i.e. processed foods, sugars, dairy, grains, etc.) to benefit avail, could be merged with the ketogenic diet to possibly amplify its fat loss effects. Whatever downside of ketogenic diets there might be could be neutralized and perhaps turned into an advantage by a diet of another form.

In any case, with a continued surge in the diets' popularity among the populace, the controversies and current inadequacy of evidence surrounding it are a clarion testimony in encouraging more deliberate research to be undertaken to ascertain the safety and efficacy of intentionally attaining ketosis via regulation of dietary choices.

Author Contributions

This paper was a team effort with each section contributed by different authors. The definition and types of ketogenic diet was written by TR, history was reported by ST, and how ketogenic became a trend and false beliefs was contributed by NJ. PS composed the mechanisms and detailed the processes of ketogenic lipolysis. PT, RC and SKa reported on physical, mental, and socio-economic effects, respectively. Supplementary courses of action including ketone powder and kosher artificial sweetener was done by SKh. Ethical issues and personal perspectives were written by TT. JT contributed to ketogenic diets and sports, and possible future solutions and applications were composed by CV.

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