Chapter

Ketogenic Diet Is Good for Aging-Related Sarcopenic Obesity

Sergey Suchkov, Tahereh Seifi Salmi, Chyi-Huey Bai, Javad Alizargar and Jia-Ping Wu

Abstract

Sarcopenic obesity is a skeletal muscle weight loss disease. It has happened at an elderly age. A ketogenic diet is a low-carbohydrate (5%), moderate protein (15%), and a higher-fat diet (80%) can help sarcopenic obese patients burn their fat more effectively. It has many benefits for muscle and fat weight loss. A ketogenic diet can be especially useful for losing excess body fat without hunger and for improving type 2 diabetes. That is because of only a few carbohydrates in the diet, the liver converts fat into fatty acids and ketones. Ketone bodies can replace higher ATP energy. This diet forces the human body to burn fat. This is a good way to lose fat weight without restriction.

Keywords: sarcopenic obesity, ketogenic diet, fat, muscle, type 2 diabetes

1. Introduction

The ketogenic diet is a mixed diet containing low carbohydrates, consisting primarily of proteins and fat [1, 2]. Some healthy foods are eaten on a ketogenic diet, for example, seafood, low-carb vegetables, cheese, eggs, meat, poultry, coffee, and tea. The importance of high fat in aging-related sarcopenic obesity reducing regimens on different metabolic models are shown by comparing the effects of four different types of ketogenic dietary regimens [3, 4]. Standard ketogenic diet (SKD): This typically contains a very low, only 5% carbohydrate, 15% moderate proteins, 80% high fat diet. This classic SKD contains a 3:1 ratio to combined protein and carbohydrate. High protein ketogenic diet (HPKD): This contains 5% carbohydrate, 35% protein, and 60% fat. This type is similar to a standard ketogenic diet, but includes more protein [5]. Cyclical ketogenic diet (CKD): This ketogenic diet involves 5 periods of ketogenic days followed by 2 high carbohydrate days [6]. Targeted ketogenic diet (TKD): This ketogenic diet allows you to add carbohydrate around workouts. Although this ketogenic diet is usually safe for weight loss, diabetes, epilepsy, and aging-related sarcopenic obesity, there maybe have some initial side effects while your body adapts [7–9]. Ketogenic diets forces to burn fats rather than carbohydrates. A ketogenic diet, a high fat, in food is converted triglyceride (TG). The liver convers triacylglycerol (TAG) into fatty acid and ketone bodies [10]. Elevated ketone bodies in the blood eventually lowers the aging-related sarcopenic obesity. We hoped to obtain the benefits of ketone dietary therapy that could be maintained indefinitely. Ketone bodies were produced β-hydroxybutyrate,

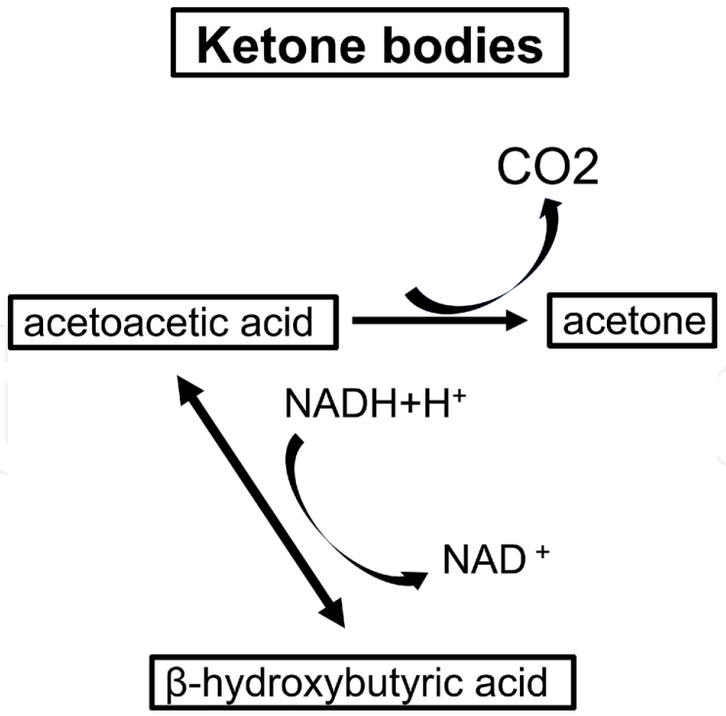

Figure 1.
Ketone bodies. Interrelationships of these three substances. Under certain a high rate of fatty acid oxidation, the liver products collectively of β-hydroxybutyrate, acetoacetate and acetone.

acetoacetate, and acetone by the liver in they consumed a very low-carbohydrate, and excess high-fat diet (**Figure 1**) [11, 12].

2. Ketogenic diet is good for aging-related sarcopenic obesity

Sarcopenic obesity is caused reduced skeletal muscle mass and strength in order adults. Sarcopenic obesity is most commonly caused by a combination of age and excessive food energy intake, not exercising enough, smoking or heavy alcohol use, although a few caused by genes [13]. Inflammation with aging is known to be a major contributor to sarcopenia [14]. Therefore, sarcopenic obesity has been defined as the loss of skeletal muscle mass and overweight in the older age. As sarcopenic obesity grow older, up to half of the muscle is lost and skeletal muscle is often replaced with fat tissue, particularly in sarcopenic obesity [15]. This is an importance of sarcopenic obesity in the health care for older people. Sarcopenia obesity starts at approximately 40 years of age and there is an estimated muscle mass loss of about 3 ~ 8% per decade, stretching process speeds up until the age of 70 years; after that age, a 15% loss ensues per decade [16]. This group proposed that sarcopenic obesity is diagnosed based on over whole-body weight combination with poor physical functioning [17].

The production of ketone bodies is from the liver. The reverse situation occurs in extrahepatic tissue. Responsible for ketone body formation are associated mainly with the mitochondria. Acetoacetate was formed from the terminal four carbons of a fatty acid upon oxidation. The liver is equipped with the production of aceto-acetate from acetoacetyl-CoA (**Figure 2**). This accounts for the net production of ketone bodies by the liver. Sarcopenic obesity is a newly recognized geriatric syn-drome by age-related decline of low skeletal muscle plus a combined approach of overweight body mass that occurs with advancing age [18]. There are several factors contributing to the disorder. Chronic low-grade inflammation has been identified as the initiator in the early stages of many disorders such as physical disability, poor

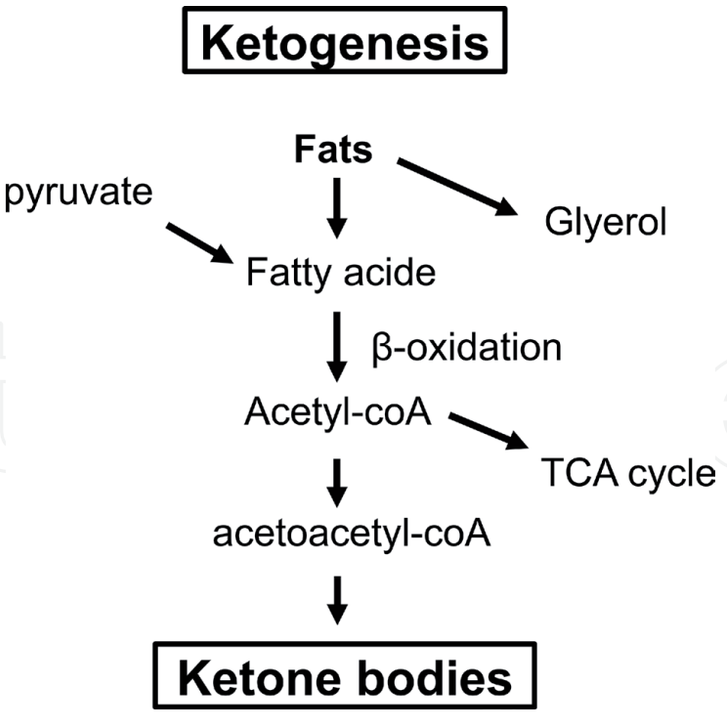

Figure 2.
Ketogenesis.

nutrition, and smoking [19, 20]. However, a widely accepted definition of sarcopenic obesity or obese sarcopenia suitable for use in research and clinical practice is still lacking. Sarcopenic obesity is increases the risk of aging-related type 2 diabetes susceptibility to obesity, and it can be the cause of functional dependence and disability in the elderly population [21]. Sarcopenic obesity was significantly associated with greater odds of sarcopenia, overfat, and sarcopenic obesity in women, but not in men [22]. Among older adult sarcopenic obesity characteristics, reduced lean mass at its extreme termed sarcopenia and excess body fatness are predictors of poor health outcomes in the general population. Sarcopenic obesity is at its extreme referred to as ketogenic diet of theorized compound these individual risks [23]. On average, by 20–40% for both men and women in sarcopenic obesity-induced muscles loss and overweight. Overall prevalence of sarcopenia was 26.7% in women and 73.3% in men, which increased with age. Prevalence of obesity was 74.6% in women and 67.1% in men [24]. Thus, defining sarcopenic obesity only in terms of muscle mass is too narrow maybe of limited clinical value that becomes more common in people over the age of 65. Sarcopenic obesity factor seropositivity, and a lack of current treatment with disease-modifying anti-sarcopenic obesity drugs were significantly associated with abnormal body composition such as increasing joint deformity, disability scores and C-reactive protein levels [25]. After middle age, adults lose 3% of their muscle strength every year, on average, to perform many routine activities [26]. These factors contribute to sarcopenic obesity to the characteristic skeletal muscle atrophy and weakness. Sarcopenic obesity also shortens life expectancy in those it affects, compared to individuals with normal muscle strength. Aging-related-sarcopenic obesity is caused by an imbalance between signals for muscle cell growth and signals for teardown [27]. Skeletal muscle cell growth processes are called "muscle anabolism," and fat cell teardown processes are called "fat catabolism" (**Figure 3**). Ketogenic diet acts with protein-destroying enzymes to keep muscle steady through a cycle of growth, stress or injury, destruction, and then healing. However, during aging your body becomes resistant to the growth signals, tipping the balance toward catabolism and muscle loss [28].

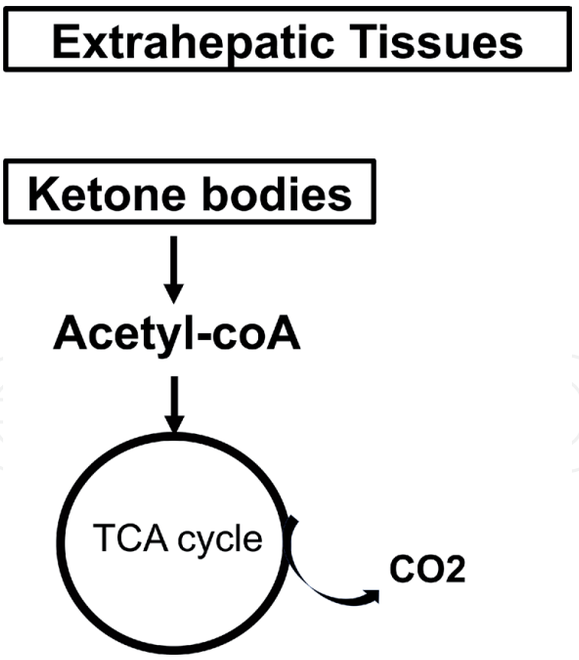

Figure 3.
The ketone bodies use. Extrahepatic tissues utilize them as respiratory substrates. The ketone bodies from the liver to the extrahepatic tissues coupled with very low activity of enzymes responsible for their utilization. Ketone bodies serve as a fuel for extrahepatic tissues.

The Older women with sarcopenic obesity have an increased all-cause mortality risk independent of obesity [29]. Sarcopenic obesity with obesity and aging, loss of muscle mass as a primary event, and this loss is a major contributor to fat gain, which in turn reinforces the muscle loss. Markedly elevated acetoacetic acid and β-hydroxybutyric acid production in the liver sarcopenic obesity. The various etiologic factors of sarcopenia in aging all lead to loss of muscle [30]. With the increase ketone body in skeletal muscle, acetoacetic acid and β-hydroxybutyric acid secretion are increased, and both lead to sarcopenic obesity resistance, which reduces the fat mass in sarcopenic obesity skeletal muscle and normal anabolic effect of insulin on amino acid transport in muscle [30, 31]. In addition, there is some evidence that acetoacetic acid and β-hydroxybutyric acid reduces fat mass secretion, suppressing another major anabolic stimulus. In addition, higher acetoacetic acid and β-hydroxybutyric acid levels may exert direct catabolic effects on muscle [32] (**Figure 4**).

Sarcopenic obesity in older adults is associated with skeletal poorer performance and strength parameters. Despite β-hydroxybutyric acid in clinical use as a therapy for sarcopenic obesity for several years, the ketogenic diet remains a therapy in search of an explanation [33]. The action of the ketogenic diet is the optimal indications for its clinical use are incompletely defined. We defined the abnormalities in body composition and abdominal fat that occur in sarcopenic obesity is associated with the aging-related presence of skeletal muscle dysfunction. Some features of clinical experience have been replicated in animal models, including the role of ketosis, elevation of triglyceride, total cholesterol, HMG CoA reductase, testosterone. Sarcopenic obesity by both classic ketogenic and β-hydroxybutyric acid diets are better effective at younger ages, and rapid reversal of the sarcopenic obesity effect when the diet is discontinued [34]. Sarcopenic obesity have been implicated in muscle atrophy and dysfunction due to denervation, muscular dystrophy, and disuse. A ketogenic diet plays key roles in sarcopenic obesity in muscle atrophy and the potential of the ketogenic diet for the treatment of sarcopenic obesity in regulating metabolism in skeletal muscle. Several β-hydroxybutyric acid isoforms are potential targets for intervention in sarcopenic obesity. Supplementary of

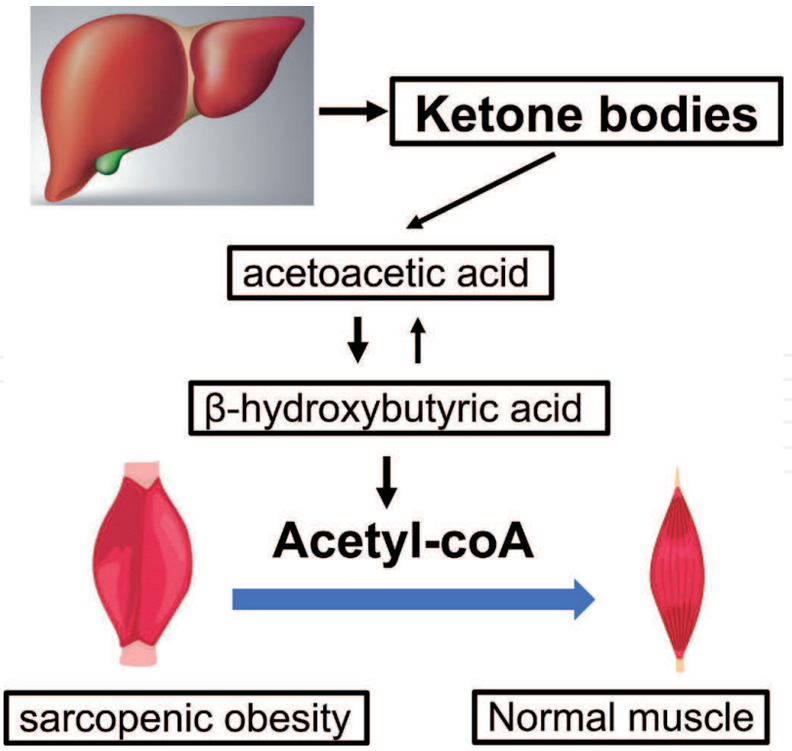

Figure 4.
A ketogenic diet can rebuild skeletal muscle. A ketogenic diet can help you lose fat in the skeletal muscle from sarcopenic obesity. β-hydroxybutyric acid provides the main fuel for moderate and high-intensity exercise.

acetoacetic acid and β-hydroxybutyric acid prevents muscle atrophy due to nutrient deprivation [35]. A ketogenic diet regulates metabolism in skeletal muscle and may inhibit oxidative metabolism during aging. Both of acetoacetic acid and β-hydroxybutyric acid have been implicated in muscle atrophy due to skeletal muscle denervation, a process implicated in sarcopenic obesity. Acetoacetic acid or β-hydroxybutyric acid is already in use in the clinic, and there is promise in targeting skeletal muscle for the treatment of sarcopenic obesity [36]. As in the clinical arena, there has been a recent resurgence of interest in pursuing basic questions related to the ketogenic diet. There have been very few animal studies of the ketogenic diet, and those that have been performed are difficult to compare because of wide discrepancies in experimental methods [37]. Earlier models concentrated on the effect of the ketogenic diet on sarcopenic obesity. The effects on the ketogenic diet and satiety, weight loss, and nitrogen balance are discussed as well as influences on electrolytes and the sympathetic system [38]. Hormonal changes of the ketogenic diet regimens and the impact on mood and subjective acceptance are compared. Experimental approaches such as brain metabolic pathways and histological techniques hold much promise in the effort to understand this intriguing alternative to standard ketogenic diet [39]. Though no recommendation for a particular dietary regimen is given, the different implications on the parameters described are pointed out. The global population is aging, the disease is younger and the influence of modern lifestyle, the clinic promotes personalized anti-aging programs, natural nutritional prescriptions, and preventive medical health management to awaken the body's original anti-aging self-healing power, allowing everyone to reverse the sub-healthy and healthy life, but it does also face the impact of modern diseases. It may be necessary to face the torture of the disease in advance, so the concept of health and advocating naturalness has gradually increased [40].

The ketogenic diet is good for your health. This results in the production of ketones, acetoacetic acid, and β-hydroxybutyric acid. The body uses for acetoacetic

acid or β-hydroxybutyric acid to burns body fats, they can lead to weight loss. The possible mechanisms are a decrease in lipogenesis, an increase in lipolysis, and an increase in the metabolic cost of gluconeogenesis. Sarcopenia, obesity and their coexistence, obese sarcopenia, as well as sarcopenic obesity, are among the greatest health concerns in the aging population. A clear age-dependent increased prevalence of sarcopenia and sarcopenic obesity has been registered in the ketogenic diet therapy patients, suggesting mechanistic relationships.

3. Conclusion and future direction

Inflammation aging is a common ground for age-related sarcopenic obesity. Ketogenic diet therapy is observed greater weight loss compared with other balanced diets. The short-term ketogenic diet is by an almost carbohydrate-free oral diet might have weight loss effectively. Therefore, we suggest the benefits of the ketogenic diet and its risks including supports weight loss, reduce risk of cancers, improve heart health, protect brain function, aging-related sarcopenic obesity, and potentially reduces seizures. In this Chapter, we discuss the aging-related sarcopenic obesity. Nutrition, β-hydroxybutyric acid, in the early development of sarcopenic obesity, cardiomyopathy, dysbiosis and age-associated diseases is our future project. We want to know about sarcopenic obesity during COVID-19 lockdown restrictions. Like many difficult global health problems, the COVID-19 solutions maybe apparent but the logistics of implementing them may be lacking.

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