Fad Diets and How They Work in the Human Body

Isabella Huner

A Senior Thesis submitted in partial fulfillment
of the requirements for graduation
in the Honors Program
Liberty University
Spring 2024

Acceptance of Senior Honors Thesis

This Senior Honors Thesis is accepted in partial
fulfillment of the requirements for graduation from the
Honors Program of Liberty University.

_____
Stephen Eakin, M.D.
Thesis Chair

_____
Willard Peveler, Ph.D.
Committee Member

_____
Marilyn Gadomski Peyton, Ph.D.
Honors Assistant Director

_____
Date

Abstract

Diets are often viewed as a quick fix to obtaining a goal weight or achieving a dream body. What people fail to understand are the processes that take place within the body while undergoing a particular diet. While some diets may aid in weight reduction, the harm put on the body is easily overlooked.

Through an in-depth analysis on three of the most popular fad diets—the ketogenic diet, intermittent fasting, and the Paleolithic diet—shows how the diet came about, how it works in the body from a basic to a cellular level, and the risks posed by these diets. Knowledge in this area might change the perspective of dieting as a whole with information about what the body is undergoing.

Fad Diets and How They Work in the Human Body

Fad Diets

Over recent years, dieting has become seemingly more and more prevalent throughout the United States. A survey was completed to discover the ways in which people attempt to lose weight; their responses indicated that ten out of the top eleven methods are related to food with 40% of those individuals engaging in dieting (Phoenix, 2024). The perception that one is overweight is something that many individuals struggle with at some point in his or her life and has become a leading cause for dieting. According to the International Food Information Council, 52% of Americans followed specific eating patterns or dieted at some point in 2023. Furthermore, the desire to lose weight and the desire to improve physical appearance were the top two motivating factors for these eating behaviors (2023 food). Food and appearance has become something Americans obsess over, but the efforts made in these areas may be more harmful than they are helpful.

Common dieting plans are often undertaken without knowledgeable information as to how the diet ought to be approached, the risks that are presented, and the ways in which the diet truly affects the body. The following information is presented to provide readers with a better understanding on some of the most popular diets and the ways in which the body is affected. This paper was written with the intent to target the healthy individual. Specific diets can be more beneficial for people diagnosed with chronic diseases due to variations in bodily processing. However, the intent of this paper was to make a generalized overview on the diets presented so that all individuals can obtain information from it and make adjustments dependent upon their individual health status.

The Ketogenic Diet

The ketogenic diet, or more commonly known as the keto diet, seems to be ever growing in popularity. In a survey conducted by the International Food Information Council, out of over one-thousand Americans, approximately 11% claim to have followed either a ketogenic, high-fat, or low-carbohydrate diet in the year 2020 (Food Insight, 2021). That is not to say every individual completed a full dieting cycle, but an effort was made. The question then becomes if these individuals can elaborate on what the keto diet truly is and how it ought to work.

Defining the Diet

The United States Food and Drug Administration (FDA) has established a 55% carbohydrate intake and a 35% fat intake from the total calories consumed in a day, but the four variations of the keto diet go to the opposite extreme ("Daily value", 2022). The standard ketogenic diet (SKD), the most well-known of keto variations, is composed of 70-80% fat, 10-20% protein, and 5-10% carbs. The cyclical ketogenic diet (CKD) and the targeted ketogenic diet (TKD) are geared towards athletes as they allow for a greater carb intake around the time of athletic training and/or competitions. The final variation is the high protein ketogenic diet (HPKD). This is similar to the SKD, but protein intake increases to 35% while fat intake decreases to 60% (Shilpa & Mohan, 2018). Overall, the concept of the keto diet is simple: limit carbohydrate intake to force the body into burning fat for energy.

Scientific Processes

Carbohydrates are the body's preferred source of energy production. When the body ingests carbs, insulin levels rise and, thus, allow glucose to enter skeletal muscle cells for immediate energy. Any remaining carbs will then be converted into glycogen to become a source of stored energy in the liver (Vargas et al., 2022). When the body is low on carbs, it will continue

energy production by pulling newly synthesized glucose from the liver and by converting lean muscle mass into glucose via gluconeogenesis. After three to four days of continual glucose depletion, insulin drops, inhibiting glucose from breaking down into pyruvate as well as supplying the brain with energy (Paoli et al., 2013). At this point, the liver uses either ingested or preexistent fatty acids to instigate a spike in ketone body production; fat has become the alternative energy source, and the body has entered ketosis (Ketosis, 2022).

The liver produces three types of ketone bodies via ketogenesis: acetoacetate, beta-hydroxybutyrate acid, and acetone. While these are present in every individual, they increase in number when the body lacks sufficient glucose. The ketone bodies are produced as the by-product of a process called gluconeogenesis; this is when the liver converts amino acids and lactate into glucose to aid the ketone bodies in providing fuel for the brain (Hatting et al. 2018). Since the products of ketosis can only supply up to 60% of the brain's energy needs, muscles and organs avoid the use of glucose and instead rely on the ketone bodies for energy (Owen et al. 1967). Eventually, the level of glucose will be reduced so much that the intermediates used for ketone body energy production will be overwhelmed by the build-up of ketone bodies (Ketone bodies, 2020).

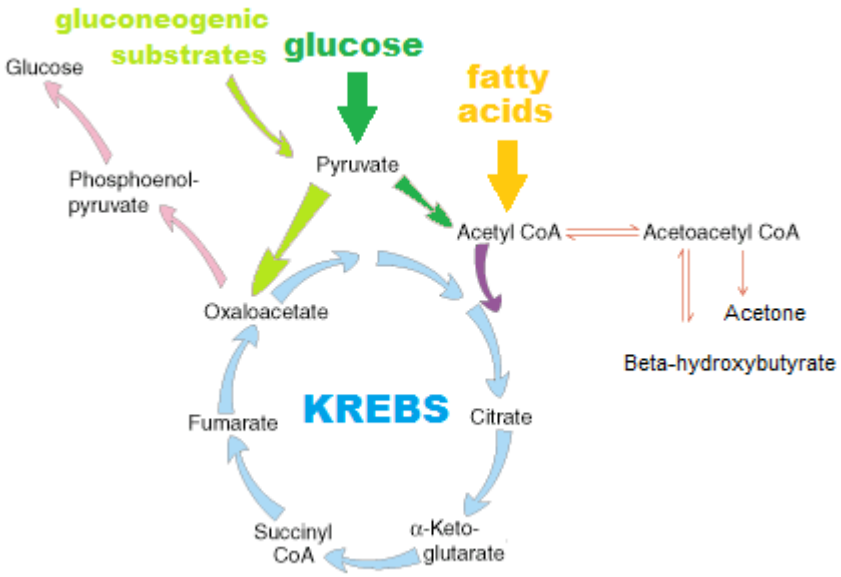
If a lack of glucose continues and the body is not getting sufficient calories elsewhere, the body will go into starvation ketoacidosis (Gall, 2020). At this time, insulin is unable to rebalance blood glucose levels. There is an uncontrollable production of acidic ketone bodies that the acid-base buffering process cannot keep up with. Bodily processes will be noticeably hindered via decreased blood pH (which decreases oxygen availability), decreased blood volume, overly excreted electrolytes, dehydration, and/or decreased lean body mass and bone mass (Mullins et al., 2011). Analysis of ketone levels in the body's system can help avoid ketoacidosis; however,

in 2020 it was reported that 70% of dieters did not track their ketone levels (Masood et al., 2022). Lack of attention to how many ketone bodies are being produced greatly reduces the chance that the body will remain in a fat burning stage.

As previously mentioned, the depletion of glucose disables the success of two essential tasks. (1) Supplying energy needs for the central nervous system (CNS). This is comprised of the brain and spinal cord and is therefore responsible for coordinating the vast majority of bodily processes including thought, emotion, movement, respiration, heartbeat, and hormones. If the CNS lacks sufficient energy from carbohydrates, then it will be restricted in carrying out these processes. Although fat breakdown yields a high energy output, the rate of energy production is much slower; thus, fats remain insufficient when supplying the brain with energy compared to carbohydrates. (2) Breaking down into pyruvate for the formation of the organic compound oxaloacetate. Fat is converted into energy through the Krebs cycle, but this process is dependent upon the availability of oxaloacetate (refer to figure 1). In the Krebs cycle, fats burn in a carbohydrate flame—carbohydrates are necessary for supplying the fundamental compounds that allow the body to burn fat for energy. Without sufficient carbs, the body cannot provide the oxaloacetate necessary to breakdown fat (Paoli et al., 2013). Regardless of the energy source utilized, glucose is necessary for fats to burn. If the body is not directly given glucose through food, it will begin to generate glucose from non-carbohydrate sources often which come from protein. In essence, the body starts breaking down what is likely trying to be built up: muscle mass (Nuttall, 2008). While the keto diet does put individuals in a fat burning state, the effectiveness and health of it is far inferior compared to a diet including carbs.

Figure 1

Krebs Cycle



Note: Land, S. (2016). "Difference between burning sugar and fat." *Siim Land.* https://siimland.com/difference-between-burning-sugar-and-fat/

Dangers

Following keto restricted eating habits severely limits the variety of nutrient intake. On this diet, 70-80% of the calories are to come from fats (Shilpa & Mohan, 2018). While there are many good sources of fats for an individual's health, there are just as many, if not more, sources of potentially harmful fats. For instance, trans-unsaturated fatty acids (trans-fats), which come about through a manufacturing process, are essentially to be omitted from an individual's daily eating habits (Trans fat, 2018). Additionally, saturated fats, which do not pose as great of a risk as trans fats, can form blockages in the arteries when consumed in high quantities (The truth about fats, 2022). Consumption of both or either of these fats increases the risk of atherosclerosis and cardiovascular disease (Graff, 2019). Despite the sources of healthy fats available, the keto

diet requires an extensive number of calories to come from fats; thus, making the ingestion of harmful fats nearly inevitable.

High fat intake paired with low carb intake severely limits the likelihood of an individual obtaining most, if not all, essential nutrients required to maintain good quality of life. Studies have found an inverse relationship stating that an increase in whole grains causes a decrease in major chronic diseases such as cancer, stroke, cardiovascular disease, coronary heart disease, and all-cause mortality (Aune et al., 2016). Furthermore, fruits and vegetables are rich in vitamins, minerals, and phytochemicals that the body needs to prevent disease, reduce inflammation, and improve overall health (Yahai et al., 2019). It is well known that whole grains, legumes, fruits, vegetables, and fiber support healthy eating habits, but since these are composed of carbs, they will be omitted from a ketogenic eating plan. While some nutrients can be obtained through other sources of food, many of them come only from fruit and vegetables. The elimination of almost an entire food group not only deprives the body of carbs, but also of the essentials to improving and maintaining proper health.

The importance of food to both physical and mental health often goes unrecognized. Reports from personal experiences suggest that the many nutritional deficiencies associated with the ketogenic diet will cause physiological and psychological changes. Carbs supply over half of the brain's energy needs; without them, the human body will be off balance as noticed through fatigue, irritability, depression, mood swings, headache, and brain fog (Harvard Health, 2022). The results of low-carb intake have become so common that they have come to be known as the "keto flu" (Bostock et al., 2020). While some of these symptoms may seem common in an individual's daily life, they are not meant to be identified as normal, and their prevalence ought to decrease alongside a healthy diet.

Synopsis

Strict adherence is required to ensure that the body is burning fat for energy and no other bodily systems are being harmed in the process. To do this successfully, however, is unlikely. As little as one non-keto meal can pull the body out of ketosis and the entire process must restart (Masood et al., 2022). In 2020, the number one reason for discontinuing a ketogenic diet plan was that it was too strict (New survey suggests, 2020). The ability to remain in ketosis and still take pleasure in eating has become an absurd thought.

There is a reason why so many individuals have had negative experiences from this diet often resulting in cheating or quitting. It is restrictive, particular, and detrimental to overall health. More problems tend to arise during and after adherence than do benefits. Obtaining true success from the keto diet is not impossible, but it is also not efficient nor is it health promoting.

Intermittent Fasting

Since the 1970s, America has seen an increase in portion and serving sizes available along with a 20-25% increase in total daily calories consumed (Scinta, 2016). The food industry promotes bigger as better, making it difficult to eat any less than the amount provided. In an effort to lose weight and lean out, individuals will remove entire meals from his or her diet to control caloric intake. Past research has established one pound of fat as equal to approximately 3,500 calories, so it would be reasonable to believe a 500-calorie deficit per day ought to result in a one-pound fat loss by the end of the week (Counting calories, 2013). To achieve this, it is simpler to eliminate a meal or snack rather than slightly reduce the amount eaten within each sitting; thus, intermittent fasting is the most likely method.

Intermittent fasting gained its popularity in 2012 when BBC broadcast journalist spoke about Dr. Michael Mosley's *Eat, Fast and Live Longer* documentary and book, *The Fast Diet.*

Through his methods of research, Mosley concluded timed eating to result in better body functioning due to the rest given from food between meals. By following a relatively low-carbohydrate diet and limiting daily intake to 800 calories per day, the body will quickly burn through carbohydrate stores—glycogen—and begin utilizing fat stores for energy (Williams, 2022).

Defining the Diet

Unlike many other diets, intermittent fasting is dependent upon the timing of food intake rather than the type of food taken in. It is a planned eating pattern containing limited or no food consumption during an identified time frame. There are many ways an individual can choose to tailor this diet plan to his/her preferences, but four methods stand out. The first being time-restricted eating—sixteen consecutive hours of the day is spent fasting, then eating returns to normal in the following eight hours, or fourteen consecutive hours of the day is spent fasting, and eating resumes in the ten hours to follow. The second method is known as the 5:2 method in which an individual's intake is limited to 500 calories for two days of the week. The third method, alternate day fasting, alternates between one day of normal eating and the next day of eating 0%-25% of an individual's normal caloric intake. Similar to alternate day fasting is the 24-hour fast, the fourth method. With this, the individual will fast for 24 consecutive hours once or twice per week. In all methods, at the days and times when fasting is not present, eating is to return to normal (Intermittent fasting how, 2022).

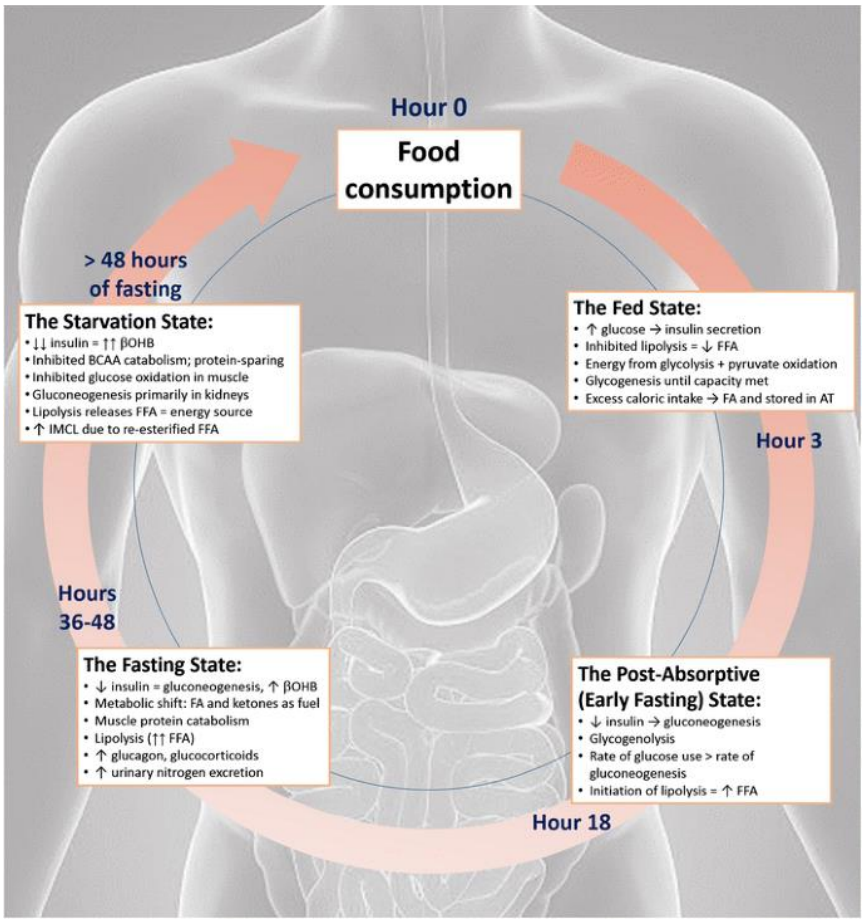
Scientific Processes

In 1963, Philip Randle, along with other scientists, theorized the glucose-fatty acid cycle to help explain the fight between glucose oxidation and fatty acid oxidation. The nutrients used by the body for energy metabolism—carbohydrates or fats—will determine the amount of energy

produced. The mechanisms building this theory have been further studied and helped create what is known as the *fed-fast cycle*. Within this cycle are four stages: the fed state, the post-absorptive state, the fasting state, and the starvation state (refer to Figure 2). An individual will only go through all four stages if practicing intermittent fasting; those following normal eating patterns, on the other hand, will only go through the first two stages: the fed state and the post-absorptive state (Stockman et al., 2018).

Figure 2

Fed-Fast Cycle



Note: Author's note: FFA (free fatty acid), FA (fatty acid), AT (adipose tissue), βOHB (beta-hydroxybutyrate), BCAA (branched-chain amino acid), IMCL (intramuscular lipids) (Stockman, et al., 2018).

Within the first few hours of eating, insulin is secreted to help lower blood sugar levels by pulling glucose in the cells. Glucose will be converted into glycogen to be stored as energy in the liver and muscles for future use. Due to the now available energy stores and increased insulin activity, lipolysis—the breakdown of fat for energy—will be impaired (Vargas et al., 2022). After three to four hours without food, the body shifts into the post-absorptive state. Energy is

pulled from previously stored glycogen until either glycogen is entirely depleted or the body receives more food. If food is ingested, then the fed-fast cycle restarts. If glycogen is not replenished, then the molecules from muscle and fat (amino acids and fatty acids) will undergo gluconeogenesis as the body starts to break down and convert these molecules into glucose. At the point of entering the fasting state, all liver glycogen has been depleted. To produce energy needed for proper functioning, the body shifts to an amino acid and fatty acid metabolic state. Reliance on these two molecules results in muscle protein breakdown and an increased production of ketones (Paoli et al., 2013). At approximately the 48-hour mark of a fast, the body enters the starvation state. Insulin levels severely drop, leading to the overproduction of the acidic ketone body: beta-hydroxybutyrate. An imbalance in the acid-base buffering process will lead to complications throughout the body such as the following: decreased oxygen availability, dehydration, and loss of muscle and bone mass (Mullins et al., 2011). Less than one-fifth of the body's amino acids (protein forming molecules) are prohibited from being catabolized—meaning, more than 80% of the body's protein is going to be converted into energy. There are, however, amino acids that convert to keto acids which become the precursor to ketone bodies. As more amino acids are used for energy, acid builds up in the system and muscle mass degrades (Rui, 2014). Furthermore, the starvation state can cause the body to become more resistant to insulin. As fatty acids are also being converted into energy, fat droplets stored in the muscle increase; these are known as intramyocellular lipids. Multiple studies have shown a correlation between the accumulation of intramyocellular lipids and impaired insulin-stimulated glucose uptake (Coen & Goodpaster, 2012). Insulin communicates with the body's cells that glucose is available for energy use. Thus, when cells do not respond as they should, glucose builds in the system and more insulin is secreted to try to keep up with the rising blood sugar levels. Any

excess glucose not used for immediate energy will be stored in the muscle cells for short-term energy or in fat cells for long-term energy (NIH study, 2010).

Dangers

Aside from the effects at the cellular level, there exist many psychological pitfalls to intermittent fasting and fasting in general. In 2021, a study was conducted requiring intermittent fasting participants to complete the Eating Disorder Examination Questionnaire (EDE-Q). The symptoms associated with the EDE-Q are as follows: restraint, eating concern, shape concern, and weight concern. Men and women in this study who participated in intermittent fasting reported significantly higher scores compared to that of the norm (Ganson et al., 2022). Most individuals desire to have a low body fat percentage, so one may unknowingly do more than what is considered safe in an attempt to get the results sought after. Though fasting can aid in the reduction of daily calorie consumption, it can easily be taken to harmful measures if an individual is desiring an even greater change.

The other extreme is that fasting may result in unrestricted eating particularly when the hormones ghrelin and leptin get involved. Ghrelin, also known as the “hunger hormone”, increases an individual’s appetite by signaling to the brain that the body needs food. An increase in this hormone occurs when the stomach is empty or near empty. Lack of food sends the body into starvation mode; thus, ghrelin signals the body to store more fat. Once food is ingested, ghrelin levels will decrease (Ghrelin, 2022). Leptin, on the other hand, suppresses appetite and secretes when energy reserves are elevated. This is either accomplished when the body is in the fed state or when the body has high levels of adipose tissue (Mendoza-Herrera et al., 2021). When the body is put through intermittent fasting, these two hormones are greatly altered. In one study conducted by the University of Birmingham, researchers discovered that more frequent

meals contributed to more stable ghrelin levels whereas a lower meal frequency—as is the case when fasting—causes ghrelin to fluctuate. During times of fasting, ghrelin was found to increase and take longer to decrease (Solomon et al. 2008). Studies have also found that a fasted state results in a decline in leptin which inevitably increases appetite levels (Triantafyllou et al., 2016). Due to the increase in ghrelin and decrease in leptin, the end of a fasting period will likely lead an individual into overeating and making poor food choices.

As with any diet, there come seemingly inevitable consequences that one might encounter. Alongside hunger hormone stimulation—and thus, hunger cravings—are also headaches, fatigue, mood changes, digestive issues, sleep disturbances, dehydration, and malnutrition (Intermittent fasting: fad, 2022). Fasting establishes low energy levels, so systems in the body must fight with working muscles to obtain enough energy to function from a state of survival. The lack of calories coming into the body places a limit on the nutrients available, which in turn sets individuals at an even greater risk of not obtaining all of the vitamins and minerals necessary to live a healthy lifestyle. Restriction of food leads to restriction in multiple areas.

Synopsis

It is likely that individuals who fast or who have fasted are overweight, underweight, malnourished, or are not enjoyable to be around (Ganson et al., 2022; Intermittent fasting: fad, 2022; Triantafyllou et al., 2016). Taking away essential nutrients and supplying the body with minimal energy takes a toll on more than one bodily system. Though intermittent fasting may seem like a quick fix to freeing oneself from unwanted fat, the true effects and harm it directs at the body say otherwise.

The Paleolithic Diet

Approximately 2.5 million years ago, during the "Old Stone Age" era, humans began to undergo anatomical and physiological changes to enhance living adaptations. It is believed that the foods consumed during this time heavily influenced adaptations such as neural expansion, brain growth, and gastrointestinal tract shrinkage (Challa et al., 2023). In 1975, Walter Voegtlin, author of *The Stone Age Diet: Based on in-depth Studies of Human Ecology and the Diet Man*, suggested that individuals follow eating habits similar to that of cavemen in an effort to counteract obesity and chronic diseases. His claim that humans are more anatomically similar to carnivorous dogs than herbivorous sheep is what forms the premise of the Paleo diet. It was not until 2001, that Dr. Loren Cordain's book, *The Paleo Diet*, popularized the concept of eating like a caveman (Beals, 2016).

Defining the Diet

Over the years, the farming industry has adopted techniques that would have been considered foreign during the Old Stone Age era. Some foods have been made more readily available while others have been newly introduced. It has been proposed that humans have not adapted to modern farming, thus, making digesting certain foods more strenuous and possibly a contributor to diabetes, obesity, and heart disease. However, a scan of over 4,000-year-old mummies determined that Paleolithic humans did, in fact, suffer from atherosclerosis despite their so-called disease preventing diet (Thompson et al., 2013). Regardless, the foods that are permitted when following the Paleo diet are as follows: grass-fed or wild game meats, fish, eggs, fruits, non-starchy vegetables, nuts and seeds. Small-scale farming foods—grains, legumes, starchy vegetables, dairy, processed foods, refined and added sugar—may not be eaten on this diet since they were not readily available to the cavemen (Paleo diet, 2022). Unlike many other

dieting techniques, calorie counting and macronutrient distribution for this diet is not mandatory, but compliance to caveman style eating is necessary.

Scientific Processes

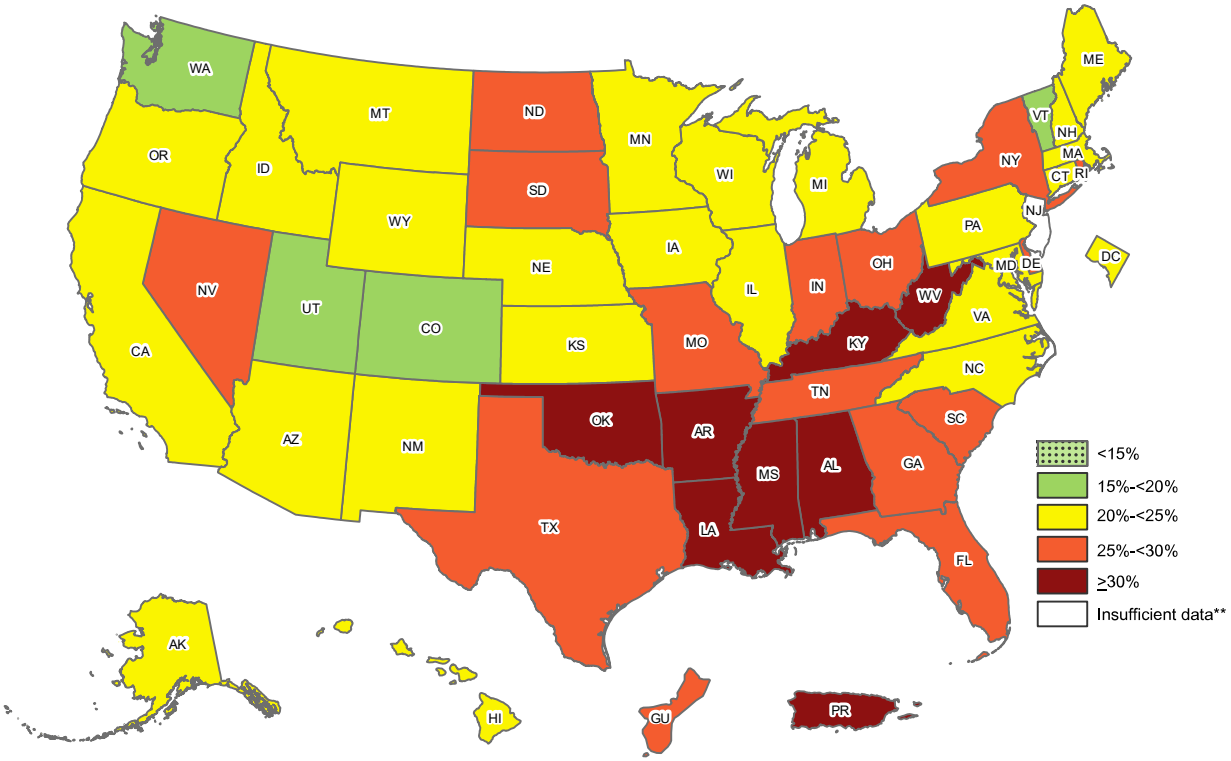
Though there are no specific requirements for quantities of each food group when following the Paleo diet, researchers have found typical macronutrient distribution to be 35% carbohydrates, 35% fats, and 30% protein. However, the United States Food and Drug Administration (FDA) recommends having a 55% carbohydrate intake to support bodily functioning (Daily value, 2022). As the body's greatest source of energy, ingested carbohydrates are either used immediately in skeletal muscle cells or they are stored as energy in the liver (Vargas et al., 2022). Without adequate carbohydrate consumption, lean muscle will go through gluconeogenesis to make glucose, the stored form of carbohydrates, from amino acids, the molecules making up lean muscle tissue. In other words, lean muscle mass will be broken down to give the body energy through newly formed glucose (Paoli et al., 2013). While the Paleo diet does not entirely omit carbohydrates, there are limited options from which this macronutrient may be obtained.

The exclusion of specific food items came about with the assumption that humans needed to eat like their ancestors in order to be at their healthiest; however, this diet fails to take into consideration factors outside of food alone. In current times there appears to be a lack of physical activity, particularly aerobic activity, which has greatly increased the risk of chronic diseases. The Centers for Disease Control and Prevention states that approximately 50% of adults don't get enough aerobic physical activity which is likely to contribute to $117 billion in health care costs (Physical inactivity, 2022). Figure 3 displays the distribution of overall physical inactivity while Figure 4 shows the prevalence of heart failure—one of the most common chronic

diseases—in the United States. It can be noted that the areas of high physical inactivity align with areas of high heart failure prevalence. As activity decreases, it is reasonable to assume that chronic diseases will continue to manifest. While diet may be a contributing factor to chronic diseases, it is not the sole factor.

Figure 3

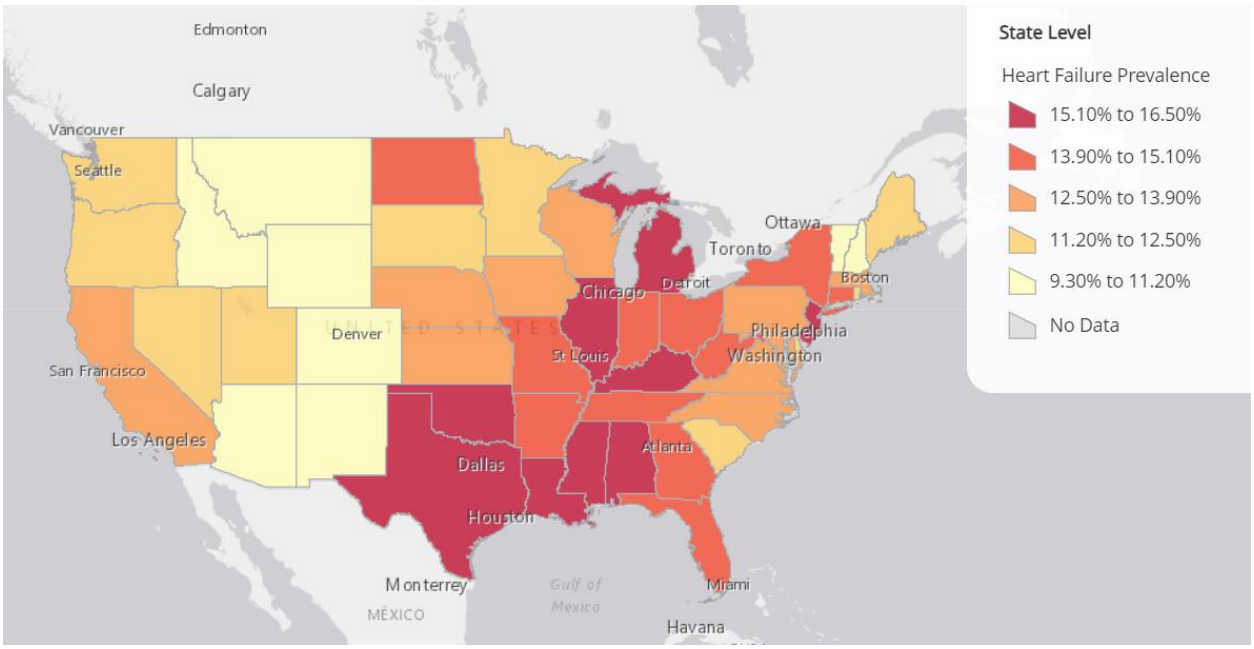
Overall Physical Inactivity



Note: This map is based on self-reported physical inactivity data from 2017-2020. A physically inactive individual qualified as someone who answered "no" to the following: "'During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?'" (Centers for Disease Control and Prevention, 2022).

Figure 4

Chronic Conditions Prevalence: Heart Failure



Note: The data on this map are current as of 2018. Centers for Medicare and Medicaid Services. (2018). "Chronic condition prevalence, state/country, 2018." https://cms-oeda.maps.arcgis.com/apps/MapSeries/index.html?appid=062934f815eb412182b3d324054ea6f0

Paleo aficionados have come to the presumption that mankind thrives best in the same environment as its ancestors, laying the claim that its ancestors were predominantly meat eaters. Research has unveiled that diets in the Paleolithic era relied upon geographical location and food availability, which often means plants were the dominant energy source. Starch granules found on the teeth and stone tools of individuals living well over 100,000 years ago indicate that tubers, wild-grown barley, and legumes were eaten (Challa et al., 2023; Gibbons, 2013; Mayo Clinic Staff, 2022). Natural selection is also said to hinder the success of modern mankind, and, therefore, humans need to best replicate the dietary habits of the past (Mayo Clinic Staff, 2022). Scientists have discredited arguments for the Paleo diet by debunking the ways humans have

stayed in line with environmental changes. For instance, lactase—the enzyme responsible for digesting milk sugars—typically shuts down after infancy causing digestive issues with any dairy consumption thereafter. As dairy has become more prevalent, some populations have developed lactase persistence, a genetic adaptation, that maintains lactase expression into adulthood (Beals, 2016; Segurel et al., 2020). The concept that humans are not evolving with the changes in farming techniques, and that the cavemen were mainly carnivorous, has led to a false way of thinking and eating.

Dangers

With the Paleo diet comes the inclusion and exclusion of various foods. As previously stated, this diet avoids small-scale farming foods as listed: grains, legumes, starchy vegetables, dairy, processed foods, refined and added sugar. While processed foods, refined sugars, and added sugars might be of little value to one's health, the excluded items present itself with an array of benefits. The U.S. Department of Agriculture acknowledges grains as part of a well-balanced diet, but the Paleo diet omits them due to a lack of nutrient uniqueness (compared to foods permitted on the diet) and an abundance of antinutrients such as gluten (Grains, n.d.; Beals, 2016). Most notably, gluten is said to disrupt the gastrointestinal tract and immune system; thus, avoiding it all together will minimize adverse effects. On the other hand, it has been argued that a gluten-free diet for healthy individuals does not provide significant benefits; rather, there is potential harm for nutritional deficiency (Niland & Cash, 2018). Furthermore, a study published in 2015 discovered no noteworthy differences among those consuming gluten and those avoiding gluten regarding performance and gastrointestinal symptoms during exercise (Lis et al., 2015).

As with grains, potatoes and legumes are prohibited due to their antinutrient content and potatoes' high glycaemic index (GI) that elicits a rapid spike in insulin. The quick rise in insulin can temporarily lead to lethargy and hunger; however, when potatoes are paired with lower GI foods, the rate at which they are digested slows (Department of Health & Human Services, 2022). Potatoes and legumes are both said to contain saponins ("soap-like" antinutrients) which theoretically aggravate the gut and cause gastrointestinal discomfort (The strong, 2023). Studies have reported that daily consumption of potato products may result in adverse effects obtained from glycoalkaloids, a potato antinutrient; however, non-sequential daily consumption is unlikely to pose a threat due to the high threshold required for intoxication (Mensinga et al., 2005). Paleo experts have also identified legumes as harmful, but for this to be true, they would need to be consumed in an unpopular fashion—lectins and phytic acid, the antinutrients found in legumes, are typically only obtained at dangerous levels when the legumes are consumed in their raw, uncooked form (Are Anti-Nutrients Harmful, 2022; Lectins, 2023). Potatoes and legumes do, in fact, contain antinutrients, but ingestion of these at toxic levels would be highly unlikely when considering the typical preparations of these foods.

The limitations from which essential vitamins and minerals can be obtained are taken a step further when dairy is also excluded from the diet. This food group provides key nutrients responsible for growth, development, and overall health (Givens, 2020). The probiotics found in dairy products enhance gut microbiome by supplying a variety of nutrients important for cellular metabolism. Some types of dairy—such as cheese, yogurt, and cottage cheese—go through a fermentation process to break down the chemical components into a more simple form. By doing this, a greater variety of microbes become available and toxins in that food are reduced. When consumed regularly, fermented foods reduce the risk of mortality, cardiovascular disease,

coronary artery disease, and stroke. Scientists have also reported dairy consumption to enhance lean muscle mass development, reduce body fat percentage, diminish the risk of cardiovascular disease, and possibly protect against type two diabetes (Mozaffarian, 2019). Dairy holds a host of benefits that can easily be missed out on if omitted from an individual's diet.

With the exclusion of certain foods, there must be an increase or addition of other food groups to achieve proper caloric intake. As previously stated, protein makes up approximately 30% of food consumed when following the Paleo diet. While this intake of protein is not of any concern, the type of protein ought to be something to take note of. Studies indicate that diets high in meat protein sources compared to those high in nonmeat protein sources lead to greater levels of low-density lipoprotein (LDL; harmful cholesterol) and its carrier, apolipoprotein B (ApoB). Regardless of blood plasma concentrations, meat protein sources tend to contain higher levels of saturated fats which in turn increases the level of these lipoproteins seen in the bloodstream (Bergeron et al., 2019). With the increase in LDL and ApoB, artery walls clog with plaque build-up, thus increasing the risk of cardiovascular disease (Stanciulescu et al., 2023). While high meat protein intake is not in itself the cause of cardiovascular disease, it does play a role in developing issues related.

Synopsis

What was once believed to be the diet of cavemen, might not be what it seems. As previously noted, researchers have been discovering more and more about their ancestors. Though sticking to the basics when it comes to food is valuable, one cannot eliminate an entire food group, especially when those foods are consumed in their natural form. Maintenace of well-balanced diet ensures individuals are not getting to much or too little of what should be good nutrition.

Disclaimer

The Paleo diet is based on ancient precepts as noted in the various scientific articles written to support this theory. Please note that the author of this paper does not support the timelines mentioned in these articles.

References

Are anti-nutrients harmful? (2022). *The Nutrition Source.* Harvard T.H. Chan. https://www.hsph.harvard.edu/ nutritionsource/antinutrients/#:~:text=However%2C%20phytic%20acid%20is%20also,well%2Dabsorbed%20in%20the%20intestine.

Aune, D., Keum, N., Giovannucci, E., Fadnes, L.T., Boffetta, P., Greenwood, D.C., et al. (2016). Whole grain consumption and risk of cardiovascular disease, cancer, and all cause and cause specific mortality: systematic review and dose-response meta-analysis of prospective studies. *British Medical Journal, 353*. doi:10.1136/bmj.i2716

Beals, K. (2016). Is a paleolithic diet the key to achieving optimal health and athletic performance? *ACSM's Health and Fitness Journal, 20*(6), 18-25. DOI: 10.1249/FIT.0000000000000253

Bergeron, N., Chiu, S., Williams, P. T., King, S. M., Krauss, R. M. (2019). Effects of red meat, white meat, and nonmeat protein sources on atherogenic lipoprotein measures in the context of low compared with high saturated fat intake: A randomized controlled trial. *The American Journal of Clinical Nutrition, 110*(1), 24-33. https://doi.org/10.1093/ajcn/nqz035

Bostock, E.C.S., Kirkby, K.C., Taylor, B.V., Hawrelak, J.A. (2020). Consumer reports of "keto flu" associated with the ketogenic diet. *Frontiers in Nutrition*, 7. https://doi.org/ 10.3389/fnut.2020.00020

Challa, HJ, Bandlamudi, M, Uppaluri, KR. (2023). Paleolithic diet. *StatPearls.* https://www.ncbi.nlm.nih.gov/books/NBK482457/

Chronic condition prevalence, state/country, 2018. (2018). *Centers for Medicare and Medicaid Services*. https://cms-oeda.maps.arcgis.com/ apps/MapSeries/index.html?appid=062934f815eb412182b3d324054ea6f0

Coen, P. M., & Goodpaster, B. H. (2012). Role of intramyocelluar lipids in human health. *Trends in endocrinology and metabolism*, *23*(8), 391–398. https://doi.org/10.1016/j.tem. 2012.05.009

Counting calories: Get back to weight-loss basics. (2023). *Weight Loss,* Mayo Clinic, https://www.mayoclinic.org/healthy-lifestyle/weight-loss/in-depth/calories/art-20048065#:~:text=If%20you%20eat%20more%20calories,(0.45%20kilogram)%20of%20fat.

Daily value on the new nutrition and supplement facts labels. (2022). *U.S. Food and Drug Administration.* https://www.fda.gov/food/new-nutrition-facts-label/daily-value-new-nutrition-and-supplement-facts-labels

Department of Health & Human Services. (2022). Carbohydrates and the glycaemic index. *Better Health Channel*. https://www.betterhealth.vic.gov.au/health/healthyliving/carbohydrates-and-the-glycaemic-index

Food Insight. (2021). 2021 Food & health survey. *International Food Information Council.* Retrieved from https://foodinsight.org/2021-food-health-survey/

Gall, A.J., Duncan, R., & Badshah, A. (2020). Starvation ketoacidosis on the acute medical take. *Royal College of Physicians.* DOI: https://doi.org/10.7861/clinmed.2020-0012

Ganson, K.T., Cuccolo, K., Hallward, L., & Nagata, J.M. (2022). Intermittent fasting: Describing engagement and associations with eating disorder behaviors and psychopathology among Canadian adolescents and young adults. *Eating Behaviors, 47*. https://www.sciencedirect.com/science/article/abs/pii/S1471015322000873?via%3Dihub

Ghrelin. (2022). Cleveland Clinic. https://my.clevelandclinic.org/health/body/22804-ghrelin

Gibbons, A. (2013). The evolution of diet. *National Geographic.* https://www.national geographic.com/foodfeatures/evolution-of-diet/#:~:text=But%20what%20they %20actually%20live,the%20ability%20to%20tolerate%20them.

Givens, D.I. (2020). MILK symposium review: The importance of milk and dairy foods in the diets of infants, adolescents, pregnant women, adults, and the elderly. *Journal of Dairy Science, 103*(11), 9681-9699. https://doi.org/10.3168/jds.2020-18296

Graff, S. (2019). A cardiologist's take on the Keto Diet. *Penn Medicine News.* https://www. pennmedicine.org/news/news-blog/2019/april/a-cardiologists-take-on-the-keto-diet#:~:text=Keto%20entails%20a%20significant%20portion%20of%20calories% 20from,atherosclerosis%2C%20which%20promotes%20coronary%20disease%20and%2 0heart%20attacks.

Grains. USDA My Plate Grains Group – One of the Five Food Groups. (n.d.). https://www.myplate.gov/eat-healthy/grains

Harvard T.H. Chan. Diet review: Ketogenic diet for weight loss. https://www.hsph.harvard. edu/nutrition source/healthy-weight/diet-reviews/ketogenicdiet/#:~:text=Generally %2C%20popular%20ketogenic%20resources%20suggest,carbohydrate%2C%20and%20 75%20grams%20protein.

Harvard T.H. Chan. (2023). Lectins. https://www.hsph.harvard.edu/ nutritionsource/anti-nutrients/lectins/

Hatting, M., Tavares, C.D.J., Sharabi, K., Rines, A.K., & Puigserver, P. (2018). Insulin regulation of gluconeogenesis. *Annals of the New York Academy of Sciences, 1411*(1), 21-35. https://doi.org/10.1111/nyas.13435

Intermittent fasting: Fad or valid weight-loss solution? (2022). *Speaking of Health*, Mayo Clinic Health System. https://www.mayoclinichealthsystem.org/hometown-health/ speaking-of-health/intermittent-fasting-fad-or-solution#:~:text=Intermittent%20fasting% 20can%20have%20unpleasant,go%20away%20within%20a%20month.

Intermittent fasting: How it works and 4 types explained. (2022). *Health Essentials*, Cleveland Clinic. https://health.clevelandclinic.org/intermittent-fasting-4-different-types-explained/

Ketone bodies. (2020). *Biology Dictionary*. https://biologydictionary.net/ketone-bodies/

Ketosis. (2022). *Cleveland Clinic*. https://my.clevelandclinic.org/health/articles/24003-ketosis

Land, S. (2016). Difference between burning sugar and fat. *Slim Land.* https://siimland. com/difference-between-burning-sugar-and-fat/

Lis, D., Stellingwerff, T., Kitic, C. M., Ahuja, K. D., & Fell, J. (2015). No effects of a short-term gluten-free diet on performance in nonceliac athletes. *Medicine and science in sports and exercise, 47*(12), 2563–2570. https://doi.org/10.1249/ MSS.0000000000000699

Map: Overall physical inactivity. (2022). *Centers for Disease Control and Prevention*. https://www.cdc.gov/ physicalactivity/data/inactivity-prevalence-maps/index.html#overall

Masood W, Annamaraju P, & Uppaluri K.R. (2022). Ketogenic diet. *StatPearls [Internet]*. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK499830/

Mendoza-Herrera, K., Florio, A. A., Moore, M., Marrero, A., Tamez, M., Bhupathiraju, S. N., & Mattei, J. (2021). The leptin system and diet: A mini review of the current evidence *Frontiers in Endocrinology, 12*, 749050. https://doi.org/10.3389/fendo.2021.749050

Mensinga, T. T., Sips, A. J. A. M., Rompelberg, C. J. M., van Twillert, K., Meulenbelt, J., van den Top. H. J., Egmond. (2005). Potato glycoalkaloids and adverse effects in humans: An ascending dose study. *Regulatory Toxicology and Pharmacology, 41*(1), 66-72. https://doi.org/10.1016/j.yrtph.2004.09.004

Mozaffarian, D. (2019). Dairy foods, obesity, and metabolic health: The role of the food matric compared with single nutrients. *Advances in Nutrition, 10*(5), 917S-923S. doi: 10.1093/advances/nmz053

Mullins, G., Hallam, C.L., & Broom, I. (2011). Ketosis, ketoacidosis and very-low-calorie diets: Putting the record straight. *Nutrition Bulletin, 36*(3), 397-402. https://doi.org/10.1111/j. 1467- 3010.2011.01916.x

New survey suggests more than twice as many Canadians have tried and dropped the “Keto Diet” than Canadians still on it. (2020). *Dalhousie University, Faculty of Agriculture.* https://cdn.dal.ca/content/dam/dalhousie/pdf/sites/agri-food/Keto%20Report%20Jan%2017%20EN.pdf

NIH study shows how insulin stimulated fat cells to take in glucose. (2010). *News Releases,* National Institutes of Health. https://www.nih.gov/news-events/news-releases/nih-study-shows-how-insulin-stimulates-fat-cells-take-glucose#:~:text=After%20food%20is%20digested%2C%20glucose,fat%20for%20long%2Dterm%20storage.

Niland, B. & Cash, B. D. (2018). Health benefits and adverse effects of a gluten-free diet in non-celiac disease patients. *Gastroenterol Hepatol*, *14*(2), 82-91. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5866307/

Nuttall, F.Q. (2008). Regulation of haptic glucose production and the role of gluconeogenesis in humans: Is the rate of gluconeogenesis constant? *Diabetes/Metabolism Research and Reviews*, *24*(6), 438-458. https://doi.org/10.1002/ dmrr.863

Owen, O.E., Morgan, A.P., Kemp, H.G., Sullivan, J.M., Herrera, M.G., & Cahill, G.F. (1967). Brain metabolism during fasting. *Journal of Clinical Investigation, 46,* 1589-1595. doi: 10.1172/JCI105650

Paleo diet: What is it and why is it so popular (2022). Nutrition and Healthy Eating. Mayo Clinic. https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/paleo-diet/art-20111182

Paoli, A., Rubini, A., & Volek, J.S. (2013). Beyond weight loss: A review of the therapeutic uses of very-low-carbohydrate (ketogenic) diets. *European Journal of Clinical Nutrition 67*, 789–796.

Phoenix, S. (2024). Weight-loss statistics 2024: Surprising facts & data. *Great Green Wall*. https://www.greatgreenwall.org/supplements/weight-loss-statistics/#:~:text=49.1%25%20of%20US%20adults%20try,women%2C%2041.7%25%20are%20men.

Physical inactivity. (2022). *Center for Chronic Disease Prevention and Health Promotion*. https://www.cdc.gov/chronicdisease/resources/publications/factsheets/physical-activity.htm

Rui, L. (2014). Energy metabolism in the liver. *Comprehensive Physiology, 4*(1), 177-197. DOI: 10.1002/cphy.c130024

Scinta, W. (2016). The history of portion sizes: How they've changed over time. *Nutrition*, YWM Blog. https://www.yourweightmatters.org/portion-sizes-changed-time/

Segurel, L., Guarino-Vignon, P., Marchi, N., Lafosse, S., Laurent, R., Bon, C., Fabre, A., Hegay, T., & Heyer, E. (2020). Why and when was lactase persistence selected for? Insights from Central Asian herders and ancient DNA. *PLoS biology, 18*(6), e3000742. https://doi.org/10.1371/journal.pbio.3000742

Shilpa, J., & Mohan, V. (2018). Ketogenic diets: Boon or bane? *The Indian Journal of Medical Research, 148*(3), 251–253. https://doi.org/10.4103/ijmr.IJMR_1666_18

Solomon, T., Chambers, E., Jeukendrup, A., Toogood, A., & Blannin, A. (2008). The effect of feeding frequency on insulin and ghrelin responses in human subjects. *British Journal of Nutrition*, 100(4), 810-819. doi:10.1017/S000711450896757X

Stanciulescu, L.A., Scafa-Udriste, A., & Dorobantu, M. (2023). Exploring the association between low-density lipoprotein subfractions and major adverse cardiovascular outcomes—A comprehensive review. *International Journal of Molecular Sciences, 24*(7), 6669. https://doi.org/10.3390/ijms24076669

Stockman, M.C., Thomas, D., Burke, J., & Apovian, C. M. (2018). Intermittent fasting: Is the wait worth the weight? *Current Obesity Reports*, 7, 172–185. https://doi.org/10.1007/s13679-018-0308-9

The strong and healthy diet. (2023). *The Paleo Diet*. https://thepaleodiet.com/

Thompson, R.C., Allam, A. H., Lombardi, G. P., Wann, L. S., Sutherland, M. L., Sutherland, J. D. Soliman, M.A., Frohlich, B., Miniberg, D.T., Monge, J.M., Vallodolid, C.M., Cox, S.L., el-Maksoud, G.A., Badr, I., Miyamoto, M.I., el-Halim Nur El-din, A., Narula, J., Finch, C.E., & Thomas, G.S. (2013). Atherosclerosis across 4000 years of human history: The Horus study of four ancient populations. *Lancet, 381*(9873), 1211–1222. https://doi.org/10.1016/S0140-6736(13)60598-X

Trans fat. (2018). *FDA.* https://www.fda.gov/food/food-additives-petitions/trans-fat

Triantafyllou, G.A., Paschou, S. A., & Mantzoros, C.S. (2016). Leptin and hormones: Energy Homeostasis. *Endocrinology and Metabolism Clinics of North America*, *45*(3), 633-645. https://doi.org/10.1016/j.ecl.2016.04.012

The truth about fats: The good, the bad, and the in-between. (2022). *Harvard Health Publishing.* https://www.health.harvard.edu/staying-healthy/the-truth-about-fats-bad-and-good

2023 food and health survey. https://foodinsight.org/wp-content/uploads/2023/05/IFIC-2023-Food-Health-Report.pdf

Vargas, E., Joy, N.V., & Sepulveda, M.A.C. (2022). Biochemistry, insulin metabolic effects. *National Library of Medicine.* StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK525983/

Williams, J. (2022). Michael Mosley praises diet method that "works better" to burn fat–you'll "see results." *Express.* https://www.express.co.uk/life-style/diets/1669841/michael-mosley-weight-loss-burn-fat-intermittent-fasting-diet-plan.

Yahia, E.M., Garcia-Solis, O., Maldonado Celis, M.E. (2019*).* Chapter 2–Contribution of fruits and vegetables to human nutrition and health. *Postharvest Physiology and Biochemistry of Fruits and Vegetables*. Woodhead Publishing. https://doi.org/10.1016/B978-0-12-813278-4.00002-6