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# Effects of High Fat Diets

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## Abstract

*With obesity on the rise, and subsequently numerous diseases, many people are looking for newer ways to counter the effects of the influx of fatty, high sugar and unhealthy foods they are consuming. The most common and widely used method is a diet plan. The key to both a healthy and effective diet is knowing what the diet does to the body. There are short term diets which have adverse effects if kept for too long and long-term diets which are aimed for a healthy lifestyle. Every diet is based on the increased and decreased consumption of different macronutrients and therefore, each affects the body differently. The Ketogenic Diet is a high fat consumption diet that is gaining credence from its success rate. However, due to it being a relatively new diet fad, there are not too many who understand the long-term adverse effects of a high fat diet.*

## Introduction

We live in a world of instant gratification. Smart phones, smart cars and smart homes are the new social norm. Another idea of the now world we live in is takeout food. Instead of preparing meals, one can be picked up or even delivered to your home at minimal charge. This would seem to be useful for person who is too busy to cook but is leading to a major problem in western culture – obesity. With obesity on the rise, many people are looking for newer ways to counter the effects of the influx of fatty, high sugar and unhealthy foods they are consuming. The most common and widely used method is a diet plan.

The word diet is simply the amount of food or drink a person consumes. When people speak about a diet though, they are referring to a special course of controlled or restricted intake of food and or drink for a particular purpose. Magazines, websites, and health moguls are promoting new diets and fads almost daily. It has reached a point where weight loss has become a societal pressure leading people to come up with numerous ‘quick fix’ diets to lose the ‘excess’ weight so as not to deviate from society.

Aside from body image concerns, there are many chronic illnesses that are related to obesity. To name a few, hypertension, diabetes, joint pain, and cardiovascular diseases, such as an acute myocardial infarction, are all largely products of unhealthy chosen lifestyles and poor dietary habits. While there are certain diets that are great in preventing, or at least not promoting, various diseases they are mistakenly used by healthy individuals who are possibly harming themselves as they are unaware of the side effects.

The aesthetics of being leaner and thinner have become the idol of, and completely overtaken, the views of almost every individual today. It has become such an obsession that new diet plans are arising daily. Some plans are more beneficial than others and some are just fads, but they are all developed on the same basis of energy expenditure.

To start with, the two biggest fat loss myths must be disproven. First, calorie counting does not work. For those who want nothing more than to hear that they can get lean and fit by only paying attention to what they eat and not how much, this idea is what they thrive on. This

is total fools play since how much you eat is significantly more important than what you eat. For example, John Cisna, a science teacher, lost 60 pounds in six months eating food bought solely from McDonalds every day. He wanted to burst the lie that people believe about food intake. While his diet plan may not have been too nutritious, it proved that you can lose weight by eating whatever junk food you would like as long as you are minimizing your calorie intake (Peterson, 2015). This kind of plan will give the wanted weight loss; however, such an eating regimen will slowly affect his visceral health if it is kept up. These types of fast foods are high in fat without many vitamins which can cause, amongst many other issues, high cholesterol levels and high blood pressure due to the buildup of plaque and therefore narrowing of the arteries.

The proper way to diet is to have a plan that is both balanced as well as nutritious. A balanced plan is consuming the proper percentage of both macro and micronutrients. Nutritious foods are ones that are rich in those nutrients that are needed daily for an organism to uphold its proper functions. Food is the material we take into our bodies to nourish it with the (hopefully) proper nutrients and other substances it needs for energy, health, and growth. Macronutrients are the substances our bodies require in large amounts. Namely protein, carbohydrates, and fats. There are also some minerals needed in relatively large quantities, but this paper will focus on fats, carbohydrates and protein as most diets pertain to altering the consumption of one of such food groups.

Secondly, it is important to understand the one most important thing about weight loss. It comes down to energy balance which is the correlation between energy intake and energy expenditure (Lean, Astrup, & Roberts, 2018). Put in more than you take out and you will have an excess amount of energy meaning you will gain weight. Eat about as much as you burn daily, and your weight will stay the same. Take in less energy than you use and there will be a deficit and you will lose weight. This is not some wild un-based theory either. According to the first law of thermodynamics, energy cannot be destroyed nor created, but can only change its form within a system. Our bodies absorb the food we eat and transform the stored energy into energy we can use. Muscles convert

the stored energy for mechanical energy, digestive system for body fat (chemical energy) and our organs convert energy into thermal energy. This is evidence how energy is never lost, but rather converted to the form each part of our body needs based on demand.

The process of our body transforming the food we intake to usable energy is one of the purposes of energy expenditure. Energy expenditure (EE) is the amount of energy that a body needs to carry out its physical and physiological functions and is measured in calories. It is the combination of a basal metabolic rate (BMR) or standard metabolic rate (SMR) and their activity level. Basal metabolic rate represents the minimum energy expenditure for a resting and fasting animal at thermoneutrality (Nilsson & Nilsson, 2016). This means BMR is the lowest sustainable energetic (caloric) cost required to keep one's body functioning at rest. Activity level is movement that requires additional energy aside from one's BMR. Activity level is not only pumping iron five days a week at the gym, it is also taking the stairs rather than the elevator during the day, mowing the lawn, changing a tire, or pushing a shopping cart. The more physical activity a person is involved in, also adds to a greater amount of energy a person expends and therefore the more s/he needs to consume.

Aside from physical activity there are other factors that play a role in determining a person's BMR - gender, body mass index, age and yes, even genetics. Due to these various factors, nutritional requirements differ from person to person and are therefore evaluated based on kilogram of body weight and every person will alter the amount based on their energy exertion during both health and disease.

It should come as no surprise then that consuming less energy than your body requires for a couple weeks or months would account for less energy in the body and therefore a leaner and leaner body type. Since energy balance has been proven to be the basic regulation for weight loss and weight gain it is found at the baseline of every proper diet plan.

In addition to dieting, it is both scientifically proven as well as seen in people's success that exercise in synchrony with a healthy diet plan is the most advantageous. Individuals who exercise along with being careful with what they eat will lose weight. They expend more calories than they take in daily and the deficit results in a loss of body weight. The Cleveland Clinic agrees and explains why exercising without a diet plan is not too effective for weight loss (Team, W., 2018). They state that in order to lose weight one of two options must be done; either one must burn more calories by working out than s/he consumes in one day or take in fewer calories alone than

one's body uses daily. To summarize, putting one's body into an energy deficit will cause weight loss and this is the basis for the majority of diet plans.

The two main types of diets are long-term plans and short-term plans. Long term diets aim to benefit a person's healthy well-being for the long haul. The results may not be instantaneous, yet the programs are easier to follow. These diets do not restrict a certain food group completely which prevents the process from becoming too arduous for someone who thinks that diets are restraining. The overall objective is a healthy lifestyle.

Alternatively, short term diets are the quick fixes. These diet plans usually see results within a week of following them. Diets that fall under this category are ones where quick weight loss is desired for aesthetic looks or necessary in preventing larger health issues, like cardiovascular disease or diabetes. These usually entail many restrictions which aside from making the dieter unwilling to stick with the plan, it makes them unhappy to comply with the rules.

One severe version of a short-term diet is known as crash dieting. These diets are severely low total calorie plans and are sustainable for a couple weeks at most. They are mostly used by bodybuilders and other professions before a performance where by eating very minimally, they can accentuate the appearance of their muscle hypertrophy. The problem begins the week after the diet is over. Many people find motivation to continue such a restricted diet in the promise of the prize. The logic behind knowing the situation is temporary gives way to individuals being able to have greater self-control which is a staple in crash diets. Additionally, in such a case not having an end goal also makes such diets extremely difficult and not very long lasting in general.

While these diets may help people lose much more weight than they would on a gradual diet plan, they are worse for the person in the long run. As an individual loses weight rapidly, their metabolism slows down. The metabolism lowers because the body tries to preserve its energy stores. This helps the short-term diet process by decreasing the 'hunger' a person would feel due to the body's adaptation to the caloric decrease. However, after such a severe low-calorie diet is over and an individual loses thirty or more pounds, their metabolism does not rise back up right away. At this point, the body requires fewer calories due to the decrease of energy metabolized. Adding much more calories to a metabolism that is designed to burn fewer amounts per day will result in increased weight and will likely leave the person worse off than where s/he started.

A large example is shown in the weight loss program

## Esther Abady

The Biggest Loser, which is a 30-week weight loss television program for bariatric adults. In 2016 a study was done on six men and eight women who participated in the show to see if the weight they lost while on the show stayed. Part of the 'Biggest Loser Study' found that the majority of the show's contestants regained a significant amount of the weight they had lost within six years after exiting the show. A few even ended up heavier than they had been before they started the competition (Fothergill et al. 2016). It was as if their bodies were intensifying their effort to pull the contestants back to their original weight (Oshin, 2020).

This phenomenon can happen to anyone, not just those on low-calories diets. For every kilogram of weight loss a person experiences, their metabolism slows down around twenty to thirty calories. But while it is burning less, the body also wants to eat more – the appetite of someone losing weight increases, making the person want to consume about one hundred calories more than they were having before. The process, known as adaptive thermogenesis, serves the purpose of regulating an organism's energy balance after changes in diet.

The body has a certain amount of fat – a “set point” – that it is comfortable with from a survival standpoint and wants to maintain. When a person begins vigorous training combined with a restrictive diet, the body responds by thinking it is under threat. The training may increase the body's muscle mass, but when the diet becomes too restrictive – which varies from person to person – leptin, the satiety hormone, begins to drop, somewhat like a starvation alarm. Leptin manifests itself as hunger and you either don't get as full from your meals, or you can't go as long between meals without getting hungry.

Nowadays, there are various lauded fad diets. One of which is called the Ketogenic diet, more commonly known as the keto diet. This diet is a short term diet based on two main goals. The primary goal is to greatly reduce the number of carbohydrates consumed. Without the intake of carbohydrates, the body cannot synthesize glucose, it's main energy source, and therefore, will need to resort to an alternate fuel. Secondly, fat consumption needs to be increased in order to become the new primary source of energy.

To reduce the intake of glucose one must consume fewer carbohydrates. Carbohydrates are the primary source of energy production in the body. When the body is deprived of carbohydrates due to reducing intake (to about less than 50g per day), insulin secretion is significantly reduced and the body enters a catabolic state. Glycogen storage depletes which forces the body to go through certain metabolic changes. Two metabolic

processes that come into action when there is low carbohydrate availability in body tissues are gluconeogenesis and ketogenesis.

Gluconeogenesis is when the body produces its own glucose. This is primarily done in the liver using lactic acid, glycerol, and certain amino acids (alanine and glutamine). When glucose availability drops further, gluconeogenesis is not enough to keep up with the needs of the body and ketogenesis begins and provides the body with ketone bodies as an alternate source of energy in the form of ketone bodies. Ketone bodies synthesized in the body can be easily utilized for energy production by heart, muscle tissue, and the kidneys. Even though the brain normally uses a large percent of the carbohydrate intake to sustain its function, it can learn to use ketone bodies as they are able to pass the blood brain barrier as well.

The ketogenic diet consists of seventy percent fat, twenty five percent protein and five percent carbohydrates. The mechanism by which the Ketogenic diet induces weight loss is by minimizing carbohydrate intake, which reduces insulin production, and thereby decreases the amount of glucose stored as fat in cells. Digested fat does not convert to glucose and thus does not activate insulin secretion. The Keto diet emphasizes high fat consumption based on the physiological metabolism of fat, where it is lysed to energy instead of being stored in adipocytes. Fat calories consumed are not stored. For the body to replace the energy it lacks from glucose, due to low carbohydrate intake, the body turns to its current reservoir of fat storage, in addition to the fatty foods, which in turn facilitates weight loss.

The basic ketone bodies that accumulate in the body during ketogenic diet, namely beta-hydroxybutyrate and acetone, are formed from the oxidation of fatty acids into acetoacetate. This metabolic state is referred to as “nutritional ketosis” and as long as the body is deprived of glucose, this ketotic state will remain.

Since ketone bodies are released only in small concentrations and don't alter the blood's pH, nutritional ketosis is quite safe. The issue arises when ketones build up in the body mainly due to diabetes, especially if combined with a disease or severe starvation. Accumulation of ketone bodies dramatically lowers the pH (increase acidity) of the blood which leads to ketoacidosis and if left untreated can eventually cause severe dehydration, coma or death.

Why are ketone bodies used as an efficient energy source in the body? Ketone bodies produce more adenosine triphosphate (ATP) in comparison to glucose, and are therefore used as an efficient energy source to the body. One hundred grams of acetoacetate generates

9400 grams of ATP, and 100 g of beta-hydroxybutyrate yields 10,500 grams of ATP; whereas, 100 grams of glucose produces only 8,700 grams of ATP. This allows the body to maintain efficient fuel production even during a caloric deficit (Masood, et. al, 2020).

An increased fat presence in the gastrointestinal tract increases satiety by stimulating the secretion of orexigenic hormones, an appetite stimulant, like GLP-1 and CCK. These hormones delay gastric emptying and decrease motility which allows food to pass through the system at a slower rate. This causes an individual to feel satiated for a longer period. This may also be the reason why many people on the ketogenic diet lose weight. Individuals on such a diet consume large amounts of fat which keeps them full in between meals. Therefore, it prevents them from snacking throughout the day and eating excessive amounts of unnecessary calories.

Over the past decade, nutrition science has produced robust evidence that high-carbohydrate diets contribute to obesity and chronic disease, and that very low-carbohydrate, ketogenic diets provide a healthy alternative. Since then, another study concluded that low-carbohydrate diets should be avoided just as much as high carb diets because they are both associated with higher overall mortality and shorter average lifespans (Bellemare & Finaret, 2018).

Both high and low percentages of carbohydrate diets were associated with increased mortality, with minimal risk observed at fifty to fifty five percent carbohydrate intake. Low carbohydrate dietary patterns favoring animal-derived protein and fat sources, from sources such as lamb, beef, pork, and chicken, were associated with higher mortality, whereas those that favored plant-derived protein and fat intake, from sources such as vegetables, nuts, peanut butter, and whole-grain breads, were associated with lower mortality, suggesting that the source of food notably modifies the association between carbohydrate intake and mortality.

The ketogenic diet was originally developed to help children with epilepsy. According to Greene, et al. (2003) "...ketones, unlike glucose, may be unable to deliver the immediate and large amount of energy necessary to initiate or sustain seizure activity". In this way, seizures can be decreased as the glucose necessary to sustain such high brain activity is not available. Furthermore, seizures would subside or become less severe in times of fasting. Fasting prevented seizure spikes. Researchers further thought of what would happen if they were to find a diet with similar effects as if one fasted - ketone bodies. Epileptics would be able to control their seizures somewhat possibly and thereby some part of their life for longer periods

of time. This led to the high fat, low carb ketogenic diet and it worked because like fasting, ketone bodies were produced and not taking in excess sugar which also peaks the strength of seizures. For certain people with epilepsy, the ketogenic diet should be followed, according to the guidelines of a certified professional, as the benefits may outweigh the disadvantages for individuals. The diet regimen may have a higher mortality rate but for them, they would rather be in better control of their lives.

In addition to preventing seizures, the ketogenic diet is believed to be related to other long-term effects as well. Since it is a relatively new concept, there hasn't been that much long-term time for research but an excess of fat in the body has many effects. Although this is the case the diet seems to be effective. A study on eighty three obese patients, with a body mass index greater than thirty five, who took part in a twenty four week ketogenic diet; reported a significant decrease in the body weight, increase in high density lipoproteins, and decrease of low density lipoproteins (Dashti et al. (2004)

People have become very interested in this diet due to its ability to reduce weight. However, people are not aware of the long-term effects this may have on their overall health. An evidence-based case study reported that the ketogenic diet can increase the risk for cardiovascular disease by twenty six percent each year. This statement is backed up by the evidence they found about this diet in particular. The ketogenic diet increases LDL, low density lipoprotein, levels because of the increased intake of saturated fat ( Dashti, et al. 2004).

LDL is a lipoprotein mainly made from cholesterol, which transports lipids from the liver to peripheral tissue for it to be stored or utilized as energy. Cells in the body have receptors that bind to LDL and engulf it via endocytosis. The cholesterol esters in the LDL can be stored or hydrolyzed into cholesterol and fatty acids to be used for hormones, bile, or the cell membrane. LDL is known as the unwanted cholesterol in the blood because of its function. It is undesirable to have stored cholesterol (a form of fat) in the organs, tissues, and cells throughout the body.

The more fat you eat - and a ketogenic diet requires a lot of fat - the more low density lipoproteins are produced, but when receiving cells are saturated by cholesterol (lipids) the residual low density lipoproteins remain in the bloodstream. This is dangerous as it can cause atherosclerosis - plaque buildup in the arteries which can lead to various cardiovascular emergencies.

Another negative side effect of high fat diets is Biliary Disease. Biliary disease is a condition that affects the bile duct whose purpose is to pass bile to the small intestine.

## Esther Abady

For example, Cholecystitis, the production of gallstones in the gallbladder, which can occur from an overconsumption of fat or increased blood cholesterol. Gallstones can block the bile duct thereby prohibiting the passage of bile. This will prevent fat from being broken down, digested, and absorbed. In theory this may sound great because if fat is not absorbed it will pass through our digestive tract without increasing the calorie intake. This is true although it will cause fatty stool and anal leakage.

An additional overwhelming issue that will be caused by Cholelithiasis (gallstones) is pancreatitis (inflammation of the pancreas). The reason why these two issues are connected is because the bile duct from the gallbladder and the pancreatic duct merge before entering the intestine. Bile from the liver and enzymes from the pancreas both pass through this common duct. When gallstones are lodged in this area, the pancreas cannot release enzymes such as proteases, lipases and amylase into the intestine. When this happens, a process known as auto digestion begins to occur where proteases like trypsin and chymotrypsin begin to digest pancreatic tissue instead of being released to break down proteins taken in by the body.

Other negative side effects of the keto diet include edema, swelling catalyzed by fluid buildup, fat necrosis, a lump of dead or damaged tissue and pancreatic hemorrhage, bleeding in the pancreas. Another issue that can arise from the keto diet is fatty liver, an increased buildup of fat in the liver. Non-alcoholic fatty liver disease (NAFLD) is asymptomatic and therefore, an individual will be unaware of this disease until the condition worsens. People on the keto diet consume such large quantities of fat that their livers overload. This is especially dangerous if sustained, because their energy stores stem from fat consumed being lysed to ketones. If the liver minimizes its bile secretion, less fat will be utilized for ketone bodies and thereby, drain the body's energy stores. This leads to fatigue, dizziness, lack of energy and motivation which in turn leads to the people being lax in their health and exercise - countering the reason they started the diet in the first place. Only once a fatty liver further manifests into hepatitis will these symptoms become prominent will the dieter seek medical attention.

A positive side effect of the ketogenic diet also primes us to burn the excess fat that so many of us are carrying around our waists. Our glucose levels return to normal, we become less insulin resistant, we shed fat, and significantly reduce our risk of developing chronic disease. Another significant benefit is the production of ketone bodies, now the subject of intense scientific investigation due to their many health-promoting properties including protection of the brain and nervous system, reduction of

systemic inflammation, the root cause of cardiovascular disease, and anti-cancer effects.

Low carbohydrate diets, which restrict carbohydrate in favor of increased protein or fat intake, or both, are a popular weight-loss strategy. However, the long-term effect of carbohydrate restriction on mortality is controversial and could depend on whether dietary carbohydrate is replaced by plant-based or animal-based fat and protein. One widely followed long-term diet that has been proven to be very beneficial and effective is the Whole Food and Plant Based diet more commonly known as the vegan diet.

In another study 15,428 adults aged forty five to sixty four were evaluated periodically through interviews where they filled out semi quantitative food frequency questionnaires. Typical portion sizes were provided as reference so that they could estimate their intake of each food item consumed. The results were adjusted for age, sex, race, total energy consumption, diabetes, cigarette smoking, physical activity, income level, and education.

In conclusion, the low carbohydrate diets that substituted the carbohydrates for animal derived fat and protein sources, such as from lamb, pork, beef, and chicken were accompanied by higher mortality. In comparison, the low carbohydrate diets that replaced carbohydrates with fat and protein from a plant base such as from vegetables, nuts and whole grain were associated with mortality. This finding suggests that the source of protein and fat in one's diet can change mortality showing that these two things are related. The optimal quantity of carbohydrates consumed in a diet should be between fifty to fifty five percent of total intake. For this reason, less than fifty percent or more than fifty percent of carbohydrates consumed seems to be ineffective (Seidemann et al 2018).

Long-term effects of a low carbohydrate diet with typically low plant and increased animal protein and fat consumption have been hypothesized to stimulate inflammatory pathways, biological ageing, and oxidative stress. On the other end of the spectrum, high carbohydrate diets, which are common in Asian and less economically advantaged nations, tend to be high in refined carbohydrates, such as white rice. These types of diets might reflect poor food quality and confer a chronically high glycemic load that can lead to negative metabolic consequences.

One diet plan based on this philosophy is the vegan diet. A study was aimed clarifying the association between vegetarian, vegan diets, risk factors for chronic diseases, risk of all-cause mortality, incidence, and mortality from cardio-cerebrovascular diseases, total cancer and specific type of cancer (colorectal, breast, prostate and lung), through meta-analysis. This comprehensive meta-analysis reported a significant protective effect of

a vegetarian diet versus the incidence and/or mortality from ischemic heart disease (-25%) and incidence from total cancer (-8%). A vegan diet conferred a significant reduced risk (-15%) of incidence from total cancer (Dinu, et. al., 2017).

In conclusion, finding a diet that suits an individual is not so simple. According to the International Society of Sports Nutrition (ISSN), there are two main positions in regard to diets. The nature of the diet and the way it influences the body composition. Each diet type has its own various sub classifications that fall under the main eating style. Therefore, while diets are a good way to lose weight, there is a point where they can do more harm than good. The keto diet is a great plan to stick with for a short while; however, consuming mostly fat every day, takes a toll on the body. Although the ketogenic diet is popular there are many long term diets that are undoubtedly safer and healthier for the body.

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