

Low Carbohydrate Diets

Low carbohydrate diets have been around for almost 200 years and have enjoyed a resurgence in popularity since 1972. The French lawyer and politician, Brillat-Savarin, is credited with first proposing a low-carb diet in 1825.

“Sure enough, carnivorous animals never grow fat (consider wolves, jackals, birds of prey, crows, etc.). Herbivorous animals do not grow fat easily, at least until age has reduced them to a state of inactivity; but they fatten very quickly as soon as they begin to be fed on potatoes, grain, or any kind of flour. ... The second of the chief causes of obesity is the floury and starchy substances which man makes the prime ingredients of his daily nourishment. As we have said already, all animals that live on farinaceous food grow fat willy-nilly; and man is no exception to the universal law.” (Jean Anthelme Brillat-Savarin)

Even in 1825, it was recognized that sugar, starch, and flour are some of the main culprits behind obesity, a lesson we apparently have forgotten or choose to conveniently ignore. While low-carb diets emerged in Europe during the 1880s, in 1921 the Ketogenic diet was first used to treat epilepsy in children. Since then several versions of low-carb diets have been proposed: (Hanan, 2018)

- The Banting-Harvey Plan (1863 – 1869)
- The Ketogenic diet (1921)
- The Inuit diet (1927)
- The alkaline diet (1935)
- The cabbage soup diet (1950)
- “Eat Fat & Grow Slim by Richard Mackarness (1958)
- The drinking man’s diet (1964)
- The Stillman or ‘doctor’s quick weight loss’ diet (1967)
- ‘Dr. Atkins’ Diet Revolution’ (1972)
- The Stone Age diet by Walter Voegtlin (1975)
- The Scarsdale diet (1978)
- The cabbage soup diet re-emerges (1982)
- Paleolithic Nutrition (1985)
- Dr. Atkins’ New Diet Revolution (1992)
- The Zone diet (1995)
- The Paleo Diet by Loren Cordain (2002)
- The South Beach Diet by Dr. Arthur Agatston (2003)
- I Quit Sugar by Sarah Wilson (2014)
- The Blood Sugar Diet (2015)
- The Pioppi Diet (2017)

Fast forward to 2018, The DIETFITS (Christopher D. Gardner & John F. Trepanowski, 2018) study was released showing no difference in weight loss between a low-carb diet (LCD) and low-fat diet (LFD).

However, the controversy remains, and the answers are not completely straightforward. First, what is an LCD?

All *low carbohydrate diets* restrict the intake of carbohydrates but, there is great variability in the amount of carbohydrate restriction and the quality of the carbohydrates restricted depending on the diet. One definition of carbohydrate content is as follows: (Robert Oh, 2019)

1. Very low-carbohydrate (<10% carbohydrates or 20–50gm/day)
2. Low-carbohydrate (<26% carbohydrates) or less than <130gm/day
3. Moderate-carbohydrate (26–44%)
4. High-carbohydrate (45% or greater)

Carbohydrate-insulin Model (CIM)

According to the CIM (Nordmann AJ, 2006) theory, our increase in carbohydrate intake makes hormonal changes that favor fat deposition. As a result of calories going into adipose (fat) tissue, fewer calories are present in the bloodstream to support the energy needs of the rest of the body. This results in hunger and overeating.

Insulin is the major hormone that affects the uptake of glucose by cells and lowers the release of energy from our fat cells. Insulin also reduces the production of ketones by the liver. As a result, it is not uncommon that when I start patients on insulin, their weight goes up! (Carlson MG, 1993)

We know that the most important modifier of how much insulin the body makes is the amount of carbohydrates we consume. Even more important than the amount of carbohydrates we consume is the type of carbohydrates we eat. Remember, from the chapter about GI and GL, the higher the index (load) the food has, the higher your blood sugar goes! Well, the higher the blood glucose goes, the higher your own bodies insulin levels go.

NOTE: only 4% of all diabetics are Type 1 diabetics in which the pancreas does not make insulin. 96% of diabetics are diabetic as a result of lifestyle – sedentary life and overeating (Statistics About Diabetes).

Most of the refined grains, potato products and sugars that you consume have a high GI; conversely, non-starchy vegetables, legumes, whole grains, and fruits have a lower GI. The GL is the single best predictor of how high your blood sugar will rise and explains almost 90% of the changes (Thomas M. S. Wolever, 1996). In contrast, dietary fat has little effect on insulin. Dietary protein does stimulate insulin a little bit but, insulin is antagonized by the hormone glucagon which protein also stimulates.

The CIM model suggests that a high-carbohydrate diet, with all the refined starchy foods and sugar we all love, increases insulin which deposits calories in fat cells instead of being used by the body.

One of the major problems I have with patients is convincing them to stop consuming refined carbohydrates. Even with the threat of insulin if they don't change. Unfortunately, the added insulin increases weight gain and hunger.

The CIM model considers overeating to be a *result* of being overweight, not the *cause*. As a result, according to the CIM model, calorie restriction is just treating the symptom and for most people, is designed to fail. A low-calorie or low-fat diet may make the problem worse by triggering the *starvation response* with increased hunger and overeating.

LCD and Keto Diet

The main objective of all LCDs is to lower insulin levels. When it comes to *rapid* weight loss, low-carb diets have proven to be superior in the first six-months up to twelve-months over all other diets (Bueno NB, 2013) (Ebbeling CB, 2012) (Tobias DK, 2015).

By reducing the amount of energy supplied from carbohydrates in your diet you are naturally increasing the amount of proteins and/or fats in your diet to compensate for the reduced energy provided by carbohydrates. Two theories have been proposed for the increased weight loss of LCDs.

- Proteins and fat make you less hungry thus increasing satiety. The increased satiety leads to consuming less food creating a calorie deficit.
- Another theory is that an LCD can ramp up your metabolism so that you are burning more calories. Some studies do support an advantage of around 200 to 300 more calories burned by the body on an LCD. (Cara B Ebbeling, 2018) (David S. Ludwig & Cara B. Ebbeling, 2018)

A very popular version of the LCD that has been used since at least 1921 is the keto diet. With the keto-diet, carbohydrates are restricted with the intention of inducing ketosis with a very low carbohydrate (VLCD) diet. When carbohydrates are restricted to less than 50gm/day the body burns its stored glycogen with the result that ketones are formed from fat tissue.

Regardless of debates, it is very clear with abundant evidence that LCDs and VLCDs work. Weight loss is rapid and continues to outperform other diets for 6-months up to 12-months.

BUT.....

Why is there always a “*but*”? I have been telling my patients for years that a low carbohydrate diet is the best way to lose weight; however, I always added the caveat that it is not a “lifestyle”, just a way to lose weight.

When the keto diet became popular, I really did not address the differences that much. Who doesn't enjoy the concept of unlimited bacon, steaks, and pork chops? Did I say bacon, I love bacon!!! Just don't eat the carbs. A meat lover's paradise, and I am a meat lover. Although my instincts told me it was not a healthy diet, the diet is so overwhelmingly popular that I caved-in.

After several years of monitoring my patients, I became an expert at determining who was on a keto diet without even asking. My patient would come in and they had lost several pounds. "Good job John, I am pleased with your weight loss." Then I would look at the blood tests. Triglycerides were down but, more importantly, the bad cholesterol (LDL) would be up.

My first question would be, "let me guess, are you on the keto diet?" To which they would always reply in the affirmative. I knew there was a problem.

I stopped recommending the keto diet; however, I continued to recommend an LCD along the lines of Atkins, high protein. This was until I read the DIETFITS study and began questioning the entire concept of LCDs (Christopher D. Gardner & John F. Trepanowski, 2018).

DIETFITS study showed no difference in 12-month weight loss between a HEALTHY low-fat diet vs a HEALTHY low-carb diet.

Hall (Kevin D Hall, 2016) also studied overweight and obese men on the keto diet in a metabolic ward. After a high-carbohydrate baseline diet (BD) for 4-weeks, they then followed a 4-week keto diet (KD). Same calories, same amount of protein in both diets. Body composition was measured with dual-energy X-ray absorptiometry and energy expenditure was measured with doubly labeled water. He found the KD did have an increased energy consumption between 57–151kcal/d compared to the BD. During the last 15 days of the BD period, the subjects lost 0.8kg of body weight. When the subjects were switched to the KD weight loss was accelerated for the first 2 weeks, but *body fat* loss slowed. During the entire four weeks of the KD, they lost 2.2kg. BUT the fat loss was identical, 0.5kg for both diets.

Another author who reviewed the literature regarding actual fat loss in an LCD vs low-fat diets concluded that an LCD is not required for body fat loss (Hirobumi Igawa, 2017).

As a result of the above studies, I began to explore not just the effectiveness of LCDs but the long-term health benefits and risks of such diets. Here are my concerns and my current state of knowledge regarding them.

- Lean tissue loss (muscle)
- Mortality and Cardiovascular Safety
- Type 2 Diabetes
- Lipid Response

LEAN TISSUE LOSS (muscle)

Almost any dietary loss of weight will include lean tissue (muscle) as part of that weight loss. A general rule of thumb that I have used since medical school days was that for every four pounds of weight loss at least one of those pounds will be muscle (Steven B. Heymsfield, 2014). This muscle loss has been credited with the so-called yo-yo effect of dieting. You lose weight dieting. You stop dieting. You go back to your old habits. You regain all your weight PLUS more.

The reason you gain more weight on the rebound (yo-yo), is that your metabolism has been damaged. Muscle is one of the main sources of metabolism in your body and if you lose muscle mass your metabolism is *slower*.

Every time you go on a rapid weight loss diet you damage your metabolism. In fact, I tell my patients that if they are not willing to exercise to maintain muscle mass, they are better off staying where they are. The exception is if they are willing to adopt a totally new and healthy lifestyle, such as the Mediterranean diet, and eat healthy for the rest of their life, then they can start the diet without exercise. Of course, I still encourage exercise.

Most studies on weight loss have focused just on the total weight ignoring the body composition of fat mass (FM) and lean mass (LM). (Linda Stern & Nayyar Iqbal, 2004). In 2018, a new study appeared discussing this very effect (Darryn Willoughby, 2018). This study showed the VLCD, i.e. keto diet, loses 25% of the weight as lean muscle mass.

One study (ITALLIE, 1976) explored the effect of an 800kcal keto diet vs an 800kcal mixed diet over a 10-day period. The keto diet lost 466.6gm/day compared to only 277.9gm/day for the mixed diet. This would seem conclusive for the keto diet, right? It turns out that the weight loss on the keto diet was 61.2% water and 35% fat. Protein loss was 3.8%. The mixed diet lost 37.1% water and 59.5% fat and protein was 3.4%. The actual amount of fat loss on the keto diet was 163.4 grams compared to 166.7 grams for the mixed diet.

Another study in 2015 examined fat and lean tissue loss in a calorie chamber (Kevin D. Hall, 2015). This was done in a controlled setting with a controlled diet and using a chamber that directly measures metabolism along with other methods to accurately calculate fat and muscle loss. This study showed the following for reduced carbs (RC) vs reduced-fat (RF) diets:

- The RC diet had more protein loss than the RF diet.
- The RF diet lost 89g of fat compared to 53g for the RC diet. Overall the RF diet had 80% greater fat loss compared to the RC diet.
- The RC had more *total weight loss* due to increased protein and water loss.

*A low-carb diet loses more WEIGHT
the low-fat diet loses more FAT*

MORTALITY AND CARDIOVASCULAR SAFETY

Short-term LCDs do promote rapid weight loss and many doctors prescribe it, including me (up to 2019). A new study (Mohsen Mazidi, 2019) evaluated the safety of LCD with mortality. The authors found the LCD diet increased overall mortality, cardiovascular disease, and cancer mortality. The diets studied had a mean value of approximately 39% calories from carbs.

While LCDs claim better cholesterol levels, reduced blood pressure, improved glucose, and insulin levels, there is still an overall increased mortality from all causes (Fung, 2010). This study also examined the difference in protein source for the LCD. When the protein source was predominately *animal*, there was a strong association with mortality. However, when the protein source was predominately *plant* in origin, there was a *decrease* in mortality.

Most of the increased mortality from LCDs is a result of the higher animal protein and associated saturated fat, *especially in the keto diet*. A large study of Swedish women followed for 15.7 years found that a 20g decrease in daily carbohydrate and a 5g increase in daily protein corresponded to a 5% increase in the risk of cardiovascular disease (Pagona Lagiou, 2012)

Studies continue to demonstrate the harmful effects of an LCD if the protein and fat source is animal. Even after a heart attack, continued reliance on a low-carb diet from animal sources (keto diet) is associated with a 50% higher mortality from a repeat heart attack. Unfortunately, switching to a plant-based LCD did not result in lower mortality (Shanshan Li & Alan Flint, 2014).

The PURE study looked at the associations of fats and carbohydrates on cardiovascular disease and mortality in 18 countries from five continents (Mahshid Dehghan, 2017). In the PURE study, higher carbohydrate intake was associated with a 28% increased risk of total mortality, but not with heart disease mortality. Interestingly, total fat was related to lower total mortality. While the fat was not associated with cardiovascular disease, saturated fat was associated with a higher risk of strokes.

Later analysis of the PURE study criticized some aspects of the included studies. Mainly the lack of information on refined vs complex carbohydrates (Eugenia Gianos, 2018). A recent study shows that plant-based diets composed of complex carbohydrates decrease cardiovascular disease while a plant-based diet with more refined foods is associated with *increased* cardiovascular disease (Ambika Satija, 2017). This author, Eugenia, also criticized the finding of increased saturated fat lowering mortality noting that in the countries studied they were *undernourished* and probably needed *any type* of additional nutrition.

Another recent study showed that a diet that changes toward whole grains, vegetables, fruit, and fish was associated with less mortality (Mercedes Sotos-Prieto, 2017).

Blood Pressure

Most weight-loss diets, LCD vs LFD vs Mediterranean diet, showed improved blood pressure. Most studies have similar effects on blood pressure reduction consistent with the meta-analysis by Bueno (Bueno NB, 2013).

Lipid Response

LCDs do raise HDL cholesterol and lower triglycerides (TG). LDL levels increase (Vijaya Surampudi, 2019)

TYPE 2 DIABETES (T2D)

Over 9% of the US population was diagnosed with T2D in 2015 and reached 25% for adults over age 65. (National Diabetes Statistics Report, 2017. Estimates National Diabetes Statistics Report, 2017. Estimates of Diabetes and Its Burden in the United States., n.d.) In regard to obesity, 87.5% of patients with T2D are overweight or obese.

The entire precept of the LCD is lowering carbohydrates and thus insulin and correcting diabetes. Again, I am equally guilty, as are most of my colleagues, in recommending an LCD to my patients to help control diabetes. Unfortunately, while I did discourage a high-fat keto-diet, I never made the distinction of plant vs. animal protein in the diet.

In one large trial (Davis NJ, 2009) studying overweight adults with T2D for at least 6 months, the LCD had faster weight loss than the LFD, but at 12 months both groups had similar weight loss.

Once more, an LCD based upon animal sources of protein, primarily processed and red meat, has a 37% increased risk of diabetes. However, a switch to plant-based protein in an LCD had a 22% lower risk of diabetes in men under age 65 (Lawrence de Koning, 2011).

In persons with T2D, there are greater improvements in the A1c with both LCDs and LFDs (H. Guldbbrand, 2012).

While it is abundantly clear that an LCD based on animal protein does promote rapid weight loss, it is not a healthy approach to diet. It is still unclear as to exactly the best combination of dietary macronutrients to promote weight loss with combined T2D and obesity (Osama Hamdy, 2018).

OPTIMAL CARBOHYDRATE INTAKE

If an LCD is not optimal for health and does not provide any benefit in long-term weight loss over other diets, what is the optimal carbohydrate amount in our diet? First, there is *no controversy* in eliminating refined and simple carbohydrates. Period.

One study (Sara B Seidelmann, September, 2018) examined 15,428 adults aged 45–64 that completed dietary surveys between 1987 and 1989. This study looked at all-cause mortality and carbohydrate intake. During the 25-year follow-up period, there was a total of 40,181 deaths.

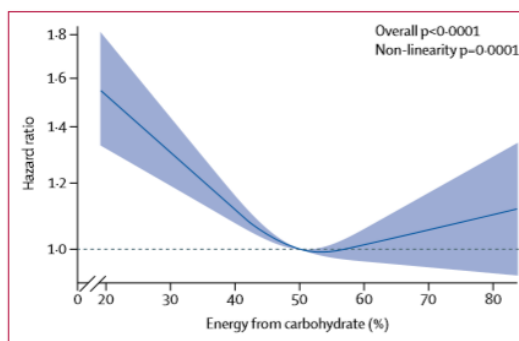


Figure 1: U-shaped association between percentage of energy from carbohydrate and all-cause mortality in the ARIC cohort
The reference level is 50% energy from carbohydrate. Results are adjusted for age, sex, race, ARIC test centre, total energy consumption, diabetes, cigarette smoking, physical activity, income level, and education. ARIC=Atherosclerosis Risk in Communities.

What this study found was that there is a “U” shaped curve associated with mortality in regard to carbohydrate intake with the minimal risk at 50–55% carbohydrate intake. Low carbohydrate (<40%) and high carbohydrate (>70%) both showed increased mortality. The carbohydrate

associated mortality was present in several cohorts including North American, European, Asian and multinational.

Possible explanations for this “U” shaped curve were provided by the authors. LCDs tended to result in lower intake of vegetables, fruits, and grains with increased animal protein. These missing foods in the LCD have more bioactive nutritional components such as branched-chain amino acids, fiber, phytochemicals, vitamins, and minerals. The lack of these components leads to increased inflammatory processes with increased biological aging and oxidative stress. The high-carbohydrate diets in this cohort meta-analysis study came primarily from Asian and economically disadvantaged nations which tend to be higher in refined carbohydrates such as white rice. This leads to a high glycemic load with negative consequences.

Low-carb diets with animal-based protein and fats have a higher mortality. Low-carb diets with plant-based protein and fats had a lower mortality.

For Reference:

The Institute of Medicine of the National Academies has a broad range of dietary recommendations: (Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids, 2002/2005)

- 45–65% from carbs
- 20–35% from fats
- 10–35% from proteins

According to the Centers for Disease Control (CDC) in 2011-2014 the average American diet was approximately 49% carbs, 16% protein, and 34% fat. A total of 11% of the total calories are from saturated fat. (Mean macronutrient intake among adults aged 20 and over, by sex and age: United States, selected years 1988-1994 through 2011-2014, n.d.) Unfortunately, this data does not include a breakdown of the *type* of carbohydrates: simple or complex.

SUMMARY

LCDs are very good at weight loss and during the first 6–12 months of the diet, LCDs lose more total *weight* than LFDs at equal calories and protein. But there are comparable total weight loss results with LFDs at 12-months. (Hession M, 2009) (Nordmann AJ, 2006). While LCDs lose more weight (from water and muscle), LFDs lose more body fat. All LCDs that are based upon animal proteins and fat have decisive health disadvantages compared to LFDs. The ideal level of carbohydrates for a healthy diet is between 50% and 55% of total energy (between 200–250gm/carb for a 1600–1800 calorie diet). The carbohydrates should be from whole grains, vegetables, and fruits avoiding all processed carbohydrates.

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