

Studies Raise Questions About Keto's Impact on Liver and Heart Health

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STORY AT-A-GLANCE

- › While short-term ketogenic diets may aid weight loss, new research links prolonged ketosis to liver stress, impaired insulin secretion, and cardiovascular problems
- › Long-term fat reliance increases circulating free fatty acids, burdening the liver, disrupting glucose regulation, and weakening metabolic flexibility – key factors in overall energy stability and heart health
- › Elevated liver enzymes and triglyceride levels on keto indicate hepatic overload. This signals that the body is struggling to manage excess fat turnover and oxidation
- › Treat keto as a short-term metabolic intervention, not a lifestyle diet. Gradually reintroduce whole-food carbohydrates to support steady energy, hormonal balance, and overall metabolic health
- › To support balanced metabolism and long-term liver and heart health, keep total fat below 30% of daily calories, eliminate seed oils from your diet, and consume sufficient dietary fiber

For several years, I recommended the ketogenic diet as a way to optimize your metabolic and mitochondrial health. Restricting carbohydrates and shifting the body to rely on fat for fuel seemed, at the time, to be a sound strategy for stabilizing blood sugar and enhancing endurance. Backed by a growing body of published research, it appeared to offer a logical and effective route toward better energy regulation and improved metabolic flexibility.

However, after studying the work of the late Ray Peat, Ph.D., my perspective shifted. His insights into the bioenergetic theory of health revealed how carbohydrate availability is tied to your body's capacity to sustain healthy energy production. The more I examined his work, the clearer it became that long-term carbohydrate restriction could work against many of the very systems it was meant to support.

Your liver and heart appear to be especially vulnerable under the metabolic strain of a high-fat, low-carb diet. That vulnerability has come under closer scrutiny in a recent *Science Advances* study¹ that examined how prolonged adherence to a ketogenic diet affects metabolic balance, insulin regulation, and organ function. Their findings raise important questions about whether keto side effects outweigh its benefits.

Does Keto Raise Liver Enzymes or Cause Fatty Liver?

In the featured study, researchers examined the long-term keto liver effects in mice for nearly a year. The goal was to determine whether a ketogenic diet, often promoted for weight management and metabolic improvement, might instead strain the liver's ability to process and regulate fat over time and compromise overall metabolic health.²

- **Liver distress emerged despite lower body weight** – The study found that even though mice on the ketogenic diet gained less weight than those fed a high-fat, high-carb diet, their liver profiles revealed signs of distress. Plasma triglycerides and non-esterified fats (free fatty acids released from stored fat) were significantly elevated, pointing to hyperlipidemia, a state of excess circulating fat in the bloodstream.

Male mice also developed hepatic steatosis (fat accumulation in the liver), along with increased alanine aminotransferase (ALT) activity. ALT is an enzyme concentrated inside liver cells and plays a role in amino acid metabolism. When liver cells are damaged or die, ALT leaks into the bloodstream, raising measurable levels. Elevated ALT directly reflects hepatocellular injury and indicates that the liver is under metabolic or inflammatory stress.

- **Broader metabolic stress accompanied liver injury** – Mice on the ketogenic diet developed glucose intolerance, meaning their bodies were less able to keep blood sugar stable after eating, and impaired insulin secretion, showing that the pancreas was not releasing enough insulin to regulate glucose. Together, these findings indicate that liver stress was part of a whole-body imbalance.

In particular, the pancreatic β cells (the cells that make and release insulin) showed disruptions in protein trafficking within the endoplasmic reticulum and Golgi apparatus, which fold and package proteins for secretion. This dysfunction resembled what is seen in early diabetes, where the machinery for insulin release becomes compromised.

- **Microscopic evidence confirmed cellular damage** – Electron microscopy revealed lipotoxic injury in the liver cells. The Golgi apparatus appeared dilated and fragmented, and genes linked to protein stress responses were upregulated. This pattern shows that long-term exposure to high lipid levels not only drives fat buildup but also interferes with protein processing and communication within cells, further aggravating liver dysfunction.
- **Animal findings suggest parallels to human liver responses** – Although this work was conducted in mice, the core mechanisms involved in fat regulation, glucose control, and protein processing are highly conserved across species. The authors wrote that their findings “have relevant translational ramifications” and “caution against the systematic use of a KD as a health-promoting dietary intervention.” The table below summarizes the animal findings alongside their human relevance:

Liver Outcomes – Enzymes and Steatosis

Aspect	Preclinical (Science Advances, 2025)	Human Relevance (as noted by authors)
Population	Mice	Not studied directly; authors emphasized the

Aspect	Preclinical (Science Advances, 2025)	Human Relevance (as noted by authors)
Exposure	Long-term ketogenic feeding (~1 year)	need for human research to confirm whether similar effects occur Prolonged high-fat intake under carbohydrate restriction may have comparable metabolic implications in humans, but further trials are required
Main signal	Marked hyperlipidemia, hepatic steatosis, elevated ALT, impaired glucose tolerance, and reduced insulin secretion	Findings carry “relevant translational ramifications,” suggesting caution when applying long-term ketogenic diets for metabolic health
Interpretation	Chronic ketogenic feeding stresses liver and pancreatic metabolism, indicating risk of liver injury and glucose dysregulation	Authors caution that extended ketogenic use could have harmful effects on metabolic health, especially regarding β -cell function, plasma lipid levels, and liver health

- **Metabolic deterioration extends beyond the liver** — In his analysis of the Science Advances study, bioenergetic researcher Georgi Dinkov added that chronic ketogenic patterns not only damage the liver but also suppress overall energy metabolism by reducing lean muscle mass. This has far-reaching metabolic consequences, since muscle is the most metabolically active tissue in the body and a major driver of resting energy use. He explained:

"[T]he resting metabolic rate (RMR) is determined primarily by the ratio of lean mass to fat mass. Thus, as the amount of muscle loss overtakes the amount of fat loss with chronic ingestion of keto diets, the RMR drops significantly. As such, after the person stops the keto diet and goes back to even low-to-moderate carb diets, the formerly keto diet patient rapidly regains the weight lost as a result of the keto diet, and regains it mostly in the form of fat.

Since fat is not nearly as metabolically active as muscle tissue, the newly re-obesified person not only regains all of the lost weight, but almost always exceeds the initial weight before the keto diet was started and finds that they keep gaining weight even if they restrict the calories way below what they used to consume prior to the keto diet.

That is due to the fact that the RMR dropped as a result of the keto diet (and muscle loss) and the regular diet, which the former keto patient used to consume and maintain a stable (though high) weight on, becomes directly obesogenic due to the much lower RMR."³

These keto side effects often develop silently, without obvious symptoms. If you notice rising liver enzymes or a dull ache under your right rib cage, it may signal that your liver is under stress from the metabolic load. That's the time to reassess your macronutrient balance before the strain turns chronic.

Why Would LDL Jump on Keto and Who Are 'Hyper-Responders'?

In a detailed review published in the American Journal of Preventive Cardiology, researchers from the Mayo Clinic examined a striking pattern among people who experience extreme cholesterol elevations while following a ketogenic diet. This group, often referred to as “hyper-responders,” shows a disproportionate increase in low-density lipoprotein (LDL) “bad” cholesterol and apolipoprotein B (apoB), the particles that actually carry cholesterol through the blood.^{4,5}

- **LDL levels spiked dramatically in keto followers** – The study reviewed clinical records of 17 adults who presented with LDL cholesterol levels above 190 milligrams per deciliter (mg/dL) while adhering to a high-fat, very-low-carb diet. Before starting keto, their mean LDL level was about 129 mg/dL. After roughly 12 months of strict adherence, that value rose by an average of 245%.
- **ApoB reflects the number of cholesterol-carrying particles** – Each LDL particle contains one molecule of apolipoprotein B (apoB), a structural protein that anchors cholesterol and triglycerides within the particle. ApoB therefore reflects not just how much cholesterol is present, but how many LDL particles are circulating. The more particles you have, the greater the chance they’ll penetrate inflamed artery walls and promote atherosclerosis, or plaque buildup.
- **Genetic predisposition amplified the effect** – Ten of the 17 patients had family histories of early heart disease or inherited lipid disorders. Five underwent genetic testing, and two carried mutations in the LDL receptor (LDL-R) gene, which impairs the body’s ability to remove LDL from circulation.

This means LDL particles linger in the blood longer, compounding the cholesterol rise. The researchers suggested that both diet composition and genetic background contributed to the extreme lipid response.

- **Lean individuals showed the greatest LDL surge** – The largest LDL increases appeared in participants with lower body mass index (BMI). The authors proposed that when carbohydrate intake is severely restricted, leaner individuals rely more heavily on fat oxidation, burning fat for fuel.

This shift ramps up production of very-low-density lipoprotein (VLDL) particles, which transport triglycerides from the liver. As VLDL offloads its fat cargo, it converts into LDL and HDL, explaining why even metabolically healthy or athletic people may see dramatic LDL spikes during keto adaptation.

- **Stopping keto reversed the effects** – In the study, when patients stopped the ketogenic diet, their LDL levels dropped by an average of 220% within nine months. This rebound emphasizes why anyone with a family history of early heart disease, lipid metabolism variants, or an unexplained rise in LDL or apoB while on keto should do so under medical supervision with regular lipid monitoring.

While the authors blamed saturated fats for higher cardiovascular risk among those on a high-fat, low-carb diet, I believe this repeats the same flawed narrative that has misled the public for decades. I'll expand on this later, but for now, remember that any discussion of keto's heart effects needs to move beyond the outdated "saturated fat equals heart disease" myth. The issue appears less about saturated fat itself and more about the metabolic overload created by extreme fat consumption.

Are Heart Palpitations on Keto a Red Flag – or Just Electrolytes?

Keto heart palpitations are among the more common side effects people notice soon after beginning this diet, especially during the first days or weeks of carbohydrate restriction. While mild, short-lived palpitations often resolve, persistent or worsening irregularity can signal deeper strain on the cardiovascular system. Recognizing this connection allows you to support your metabolism without ignoring what your heart is telling you.^{6,7}

- **Electrolyte loss drives early palpitations** – When carbohydrate intake drops sharply, insulin levels fall and glycogen (stored carbohydrate) is depleted. This shift prompts the kidneys to excrete water along with key minerals, such as sodium, potassium, and magnesium.

These are the body's electrolytes, which regulate the electrical signals that control heartbeat and muscle contraction. As they drop, the heart's rhythm can become irregular or faster than usual (tachycardia), especially if hydration is inadequate. Replenishing electrolytes typically stabilizes symptoms within days.

- **Fat-based fuel changes cardiac metabolism** – Because ketogenic diets push the heart to depend almost entirely on fat oxidation instead of glucose for fuel, this metabolic shift can have unintended effects on cardiac performance, including disturbances in the heart's electrical rhythm.

Experimental studies in animals also indicate that long-term ketogenic feeding may promote adverse remodeling of the heart muscle – characterized by fibrosis and changes in tissue structure – that can interfere with normal electrical conduction and raise the likelihood of arrhythmias such as atrial fibrillation.⁸

- **When to address symptoms** – Occasional palpitations during keto adaptation often resolve with hydration and mineral-rich foods like leafy greens and bone broth. However, ongoing rapid or irregular heartbeats, chest tightness, or palpitations accompanied by dizziness or shortness of breath require prompt evaluation. These may reflect electrical or structural strain on the heart, especially in individuals with high cholesterol, high blood pressure, or pre-existing heart disease.
- **Simple checks before medical evaluation** – Ensure adequate hydration, avoid caffeine and stimulant intake, and reassess whether palpitations persist once electrolytes stabilize. Thyroid hormone dosing, anemia, and overtraining can also contribute. If the symptoms continue after addressing these factors, a medical evaluation is essential. A basic electrocardiogram (ECG) and blood panel can identify early electrical or metabolic disturbances before they progress.

Learn more about the cardiovascular effects of ketogenic diets in [“The Ketogenic Diet Can Put Your Cardiovascular Health at Risk.”](#)

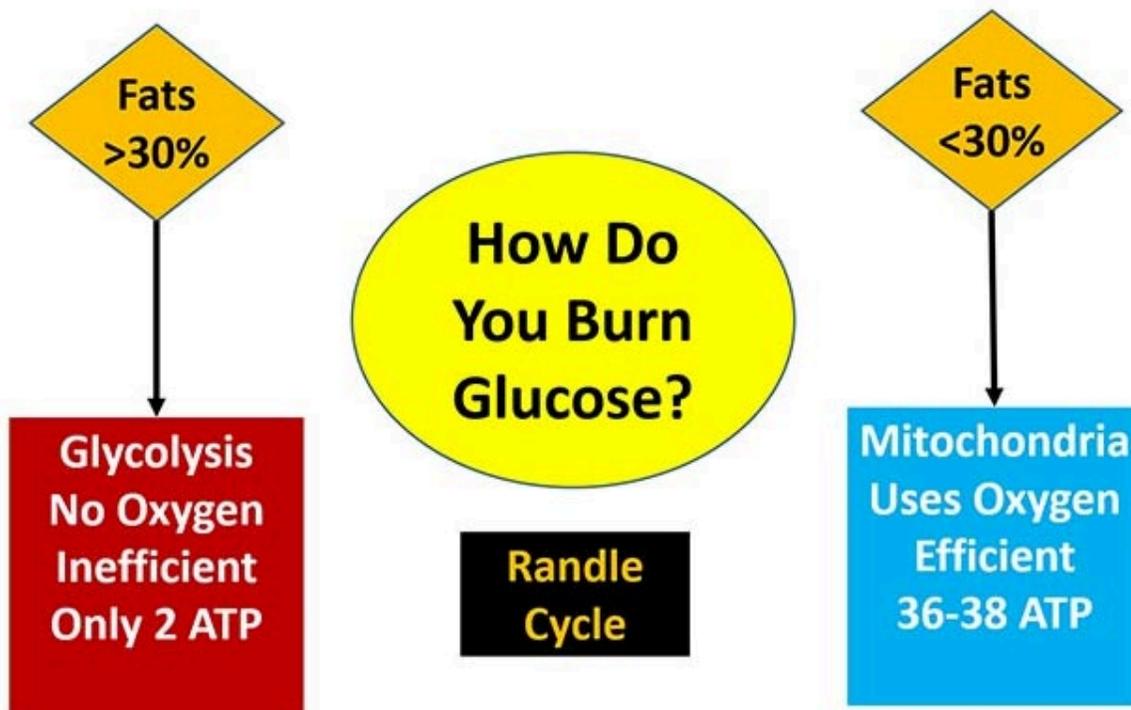
Could a Higher-Carb, Lower-Fat Diet Be Safer for Your Heart and Liver?

The fact is, your body requires glucose to function properly. When carbohydrate intake drops too low for too long, your body compensates by producing glucose from cortisol through a process called gluconeogenesis. This involves breaking down amino acids from muscle tissue to create glucose for essential energy needs.

- **Cortisol's real role in metabolism** – Cortisol belongs to a class of steroid hormones called glucocorticoids.⁹ The prefix gluco refers to glucose (sugar),¹⁰ while cortico indicates its origin in the adrenal cortex.¹¹

Although commonly labeled a stress hormone, cortisol's primary biological purpose is to raise blood sugar when glucose and glycogen (the liver's stored form of glucose) run low. When this shortage is detected, cortisol activates the PEPCK enzyme, triggering gluconeogenesis.¹²

- **Chronic cortisol elevation signals metabolic imbalance** – When cortisol remains elevated due to prolonged carb restriction, it drives inflammation and weakens immune function.¹³ This persistent stress state undermines long-term metabolic and hormonal health. While low-carb diets may promote short-term weight loss or glycemic control, sustained glucose deprivation pushes the body into a stress-driven, catabolic mode, breaking down tissue to meet energy needs.
- **The Randle Cycle explains fat-glucose competition** – Insights from Peat's bioenergetic framework and related metabolic research highlight the Randle Cycle, a cellular "fuel switch" that determines whether your mitochondria burn fat or glucose at a given time. Think of it as a railroad junction – only one train (fuel source) can pass at once.



- **For efficient glucose metabolism, the fat load must remain moderate** – When dietary fat exceeds about 30% of total calories – lower if you’re overweight – the body shifts toward fat oxidation. This suppresses glucose use inside mitochondria, forcing glucose to remain in the bloodstream and raising blood sugar.

Balancing carbohydrate and fat intake ensures the Randle Cycle stays aligned with energy demand rather than metabolic stress. In a previous [interview I had with Dinkov](#), he explained:

“I’ve noticed that between 15% and 20% [dietary fat] is probably where most people, in their current health state, can metabolize the fat without causing problems for the glucose through the Randle cycle. Especially Type 2 diabetics.

Most of them are overweight or obese, which means they have two sources of fats – one through the diet and the second one from their fatty tissue, because there’s always some lipolysis going on. So for diabetic people, it’s probably a good idea to lower the intake of fat from the diet, because they already have a lot coming from their own bodies.

There's so many clinics around the world that treat and even cure Type 2 diabetes by putting them on a really restrictive diet until they lose most of their fat. And then suddenly, the metabolism of glucose gets restarted. I think this directly shows you that the problem with glucose wasn't the glucose itself.

It wasn't the glucose that was fattening them up. They had too much fat in their bodies, and once you get rid of that fat, no matter how you do it, the problems when metabolizing glucose disappear which, to me, is a great testament to the Randle Cycle."

Shifting from a chronically low-carb pattern to a more balanced, carbohydrate-inclusive diet is one of the simplest ways to restore metabolic stability. By doing so, you create an internal environment where both your heart and liver can function at their natural pace – energetic, steady, and free of the constant biochemical tension that defines long-term ketosis. For a deeper look at why glucose is the body's cleanest, most efficient fuel, read ["Glucose – The Ideal Fuel for Your Cells."](#)

Rebalancing Your Macronutrients for Optimal Metabolism

When it comes to adjusting your macronutrient intake, a sensible approach is needed. The goal is not to fear any one macronutrient but to use each in the right proportion to keep metabolism functioning optimally.

- 1. Moderate your fat intake** – While you need to lessen your fat consumption, that doesn't mean fats need to be removed from your diet entirely. Make no mistake, fats – especially from clean, stable sources – remain essential for optimal health. The goal is to keep total dietary fat below 30% of your daily calories.
- 2. Eliminate [linoleic acid \(LA\)](#) from your diet** – Common sources include seed oils like soybean, corn, canola, sunflower, and safflower oils, from your diet. Keep your LA intake below 5 grams a day – and if possible, under 2 grams. Replace industrial oils with traditional fats that resist oxidation, such as butter, tallow, and coconut oil.

For decades, government dietary policies encouraged Americans to replace these traditional fats with so-called “heart-healthy” vegetable oils. These guidelines, based on outdated lipid theories, convinced much of the public that seed oils were safer than saturated fats. Yet modern biochemical and clinical evidence shows that LA oxidizes easily, producing toxic byproducts that damage cells, fuel inflammation, and increase oxidative stress.^{14,15}

To help you keep track of your intake, I recommend you download the [Mercola Health Coach app](#), which will be out this year. One of its main features is the Seed Oil Sleuth, which calculates your vegetable oil intake to the tenth of a gram.

- 3. Choose healthy carbohydrates** — Replace refined starches and processed sugars with nutrient-dense, whole-food carbohydrates like ripe fruits, root vegetables, sweet potatoes, and white rice. These restore glycogen stores in your liver and muscles, regulate blood sugar, and reduce the stress-driven glucose production that occurs during low-carb restriction.

Including resistant starches such as green bananas or cooked-and-cooled potatoes also feeds beneficial bacteria, increasing short-chain fatty acids (SCFAs) like butyrate that calm inflammation and protect the gut lining.

- 4. Consume sufficient dietary fiber** — It’s ideal to consume about 30 grams of fiber. However, if your gut is inflamed or imbalanced, increase fiber gradually since pathogenic bacteria can also ferment it, producing endotoxins.

As your gut flora normalizes, aim for 200 to 250 grams of carbohydrates from whole, unprocessed foods to fully support microbial diversity and mucosal healing. For an in-depth understanding of this approach, read “[Butyrate — The Metabolic Powerhouse Fueling the Gut and Beyond.](#)”

- 5. Know when to use keto** — While increasing your carb intake can help promote better health, that doesn’t mean the ketogenic diet will never have a place in a wellness regimen. In fact, I still recommend it if you’re just getting your health back on track,

as it's initially useful to help you become more metabolically flexible. But, while short-term keto has several benefits, prolonged ketosis, as discussed throughout this article, can be problematic.

When using keto as a short-term metabolic reset, it's important to monitor how your body responds. The table below outlines key markers that show whether the diet is supporting recovery or beginning to strain metabolic balance.

Key Markers to Watch on a Ketogenic Diet

Marker	Typical Keto Effect	When to Worry	Practical Levers
LDL/apoB	May rise sharply in "hyper-responders," especially lean individuals	A large or sustained increase from baseline, especially with signs of oxidative stress or inflammation	Eliminate seed oils and other LA sources; prioritize stable fats like butter, tallow, and coconut oil; increase antioxidant-rich foods (vitamin E, polyphenols); optimize thyroid and liver function
Triglycerides	Commonly decrease during early keto adaptation	A paradoxical rise, often from excess calories, alcohol, or impaired fat oxidation	Avoid alcohol and reduce total fat intake; include more fiber and whole-food carbohydrates to improve fat clearance

Marker	Typical Keto Effect	When to Worry	Practical Levers
HDL	Typically increases modestly	Not a concern unless paired with inflammation or high apoB	Maintain balanced nutrition and oxidative stability; HDL rise alone doesn't offset metabolic stress
Arrhythmia symptoms	Palpitations often tied to electrolyte loss or thyroid shifts	Persistent palpitations, irregular ECG, chest tightness, or dizziness	Rehydrate; restore electrolytes (sodium, magnesium, potassium); address thyroid and adrenal balance; seek medical evaluation if symptoms persist

Frequently Asked Questions (FAQs) About the Ketogenic Diet

Q: Does keto cause fatty liver or help reverse it?

A: The Science Advances study showed that long-term ketosis elevated free fatty acids, hyperlipidemia, and fat accumulation inside liver cells – classic signs of hepatic steatosis. These changes occurred even without weight gain, showing that

fat overload, not calories alone, can injure the liver. In essence, keto may appear helpful early on, but extended use risks shifting the liver from fat-burning to fat-burdened.

Q: Can a ketogenic diet raise LDL even if I'm losing weight?

A: Yes. The Mayo Clinic review documented sharp LDL and apoB increases among “hyper-responders,” many of whom were lean and metabolically healthy. Weight loss itself doesn't prevent this, because the rise in circulating fats reflects how the body processes fat for fuel under severe carb restriction – not just how much fat it stores.

Q: Why are my alanine aminotransferase (ALT) levels high after starting keto?

A: ALT is an enzyme found primarily in liver cells, and elevated levels usually signal that the liver is under stress. During the early stages of keto, fat breakdown accelerates, flooding the liver with free fatty acids to convert into ketones. This sudden metabolic load can temporarily raise ALT.

However, if levels stay elevated, it may indicate that excess fat is accumulating in liver cells or that oxidative stress is damaging them. Persistent ALT elevation means the liver is struggling to keep up with fat processing – a sign that the diet may be doing more harm than good.

Q: Are heart palpitations on keto normal?

A: Transient palpitations are common during the first days or weeks of carbohydrate restriction because of fluid and electrolyte losses. When glycogen stores drop, the kidneys excrete sodium, magnesium, and potassium – minerals essential for

normal heart rhythm. If palpitations persist after hydration and electrolyte restoration, or are accompanied by dizziness or chest tightness, you should seek medical evaluation.

Q: What do U.S. guidelines say about high-fat patterns and heart risk?

A: For decades, U.S. dietary policy has promoted a low-saturated-fat approach for heart health, encouraging Americans to rely on so-called “heart-healthy” vegetable oils like soybean, corn, canola, and sunflower.

However, while moderating overall fat intake is wise, natural saturated fats from traditional sources like grass fed butter, eggs, and meat are not the problem. The real focus should be on eliminating unstable industrial oils and restoring a balanced, nutrient-dense diet that includes whole-food carbohydrates for sustained metabolic health.

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