

How Linoleic Acid Wrecks Your Health

Analysis by [Dr. Joseph Mercola](#) ✓ Fact Checked

STORY AT-A-GLANCE

- › Linoleic acid (LA) makes up the bulk — about 60% to 80% — of omega-6 and is the primary contributor to nearly all chronic diseases. While considered an essential fat, when consumed in excessive amounts, LA acts as a metabolic poison
- › Polyunsaturated fats such as LA are highly susceptible to oxidation, which means the fat breaks down into harmful subcomponents. OXLAMS (oxidated LA metabolites) are what cause the damage
- › Over the last 150 years, the LA in the human diet has increased from about 2 to 3 grams a day to 30 or 40 grams. LA used to make up 1% to 3% of the energy in the human diet and now it makes up 15% to 20%
- › The omega-3 to omega-6 ratio is also very important, but simply increasing the amount of omega-3 that you eat is ill advised. You really need to minimize your omega-6 to prevent damage
- › At a molecular level, excess LA consumption damages your metabolism and impedes your body's ability to generate energy in your mitochondria

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In this interview, Tucker Goodrich and I discuss what will be the topic of my next book, namely linoleic acid (LA), which I believe is likely the leading contributing cause of virtually all chronic diseases we've encountered over the last century. Unfortunately, this

is a topic that most clinicians and health care practitioners who focus on natural medicine have only a superficial understanding of.

Goodrich has a business background as a stockbroker and asset manager, and developed an IT risk management system used by two of the largest hedge funds in the world. A string of health crises in his late 30s and early 40s prompted him to apply his research and troubleshooting skills to medical research.

As noted by Goodrich, "It was a very upsetting time in my life and medical professionals really weren't any help at all in trying to figure out what caused things." After a lot of reading and researching, he decided to cut out seed oils from his diet, and in just two days, his 16-year-long bout with irritable bowel disease started to dramatically improve.

"I started immediately feeling better," he says. He also lost a significant amount of weight over the next two months. After that, he stopped eating carbs and realized he must have had a severe case of gluten intolerance.

"Being an engineer by trade, I did a lot of experimenting. What can I eat? What brings back the symptoms? What do I have to avoid to keep the symptoms away? And it was a transformation that made everybody I worked with comment on what a difference they saw in me. It was a very quick change," he says.

Avoiding Omega-6 Fats Is Key for Good Health

While considered an essential fat, when consumed in excessive amounts, which over 99% of people do, LA (an omega-6 polyunsaturated fat or PUFA) acts as a metabolic poison.

Most clinicians who value nutritional interventions to optimize health understand that vegetable oils, which are loaded with omega-6 PUFA, are something to be avoided. What most fail to appreciate is that even if you eliminate the vegetable oils and avoid them like the plague, you may still be missing the mark.

Chances are you're still getting too much of this dangerous fat from supposedly healthy food sources such as olive oil and chicken (which are fed LA-rich grains).

Another common mistake is to simply increase the amount of omega-3 that you eat. Many are now aware that the omega-3 to omega-6 ratio is very important, and should be about equal, but simply increasing omega-3 can be a dangerous strategy. You really need to minimize the omega-6. As explained by Goodrich:

"The ratio is not really what's important. What's important is avoiding the omega-6 fats. There are disease models, like age-related macular degeneration (AMD), where that's starting to be clearly understood, and you can find papers saying explicitly that the important intervention that prevents AMD from progressing is reduction of omega-6 fats, and you can't prevent it by increasing your omega-3 fats.

I've got papers that show, in animal models, very nasty outcomes, such as liver failure, with a lower omega-6 to omega-3 ratio, but high absolute levels of both fats still allows pathology to progress."

LA Is a Primary Contributor to Chronic Disease

When we talk about omega-6, we're really referring to LA. They're largely synonymous, as LA makes up the bulk – about 60% to 80% – of omega-6 and is the primary contributor to disease. Broadly speaking, there are three types of fats:

- Saturated fats, which have a full complement of hydrogen atoms
- Monounsaturated fats, which are missing a single hydrogen atom
- PUFAs, which are missing multiple hydrogen atoms

The missing hydrogen atoms make PUFAs highly susceptible to oxidation, which means the fat breaks down into harmful metabolites. OXLAMS (oxidized LA metabolites) are what have a profoundly negative impact on human health. While excess sugar is

certainly bad for your health and should be limited to 25 grams per day or less, it doesn't oxidize like LA does so it's nowhere near as damaging.

Over the last century, thanks to fatally flawed research suggesting saturated animal fat caused heart disease, the LA in the human diet has dramatically increased, from about 2 to 3 grams a day 150 years ago, to 30 or 40 grams a day. Goodrich cites research showing LA used to make up 1% to 3% of the energy in the human diet and now it makes up 15% to 20%.

In my mind, this radical change has had the most catastrophic impact on human health in the history of the human race, as it is the complete opposite of what you need for optimal health. This dietary change has undoubtedly killed millions, probably hundreds of millions, prematurely and still continues to do so because people don't understand this.

"I'm a speed reader and I love reading medical journals ... but what nobody's really done is connect all the dots. There are a lot of people who understand little sections of [the science], but they haven't gone on to coalesce everything into a common explanation for these pathologies across different disease states.

I think that's what I've been able to do, and I think that's the key insight that makes this message really compelling," Goodrich says.

On a side note, do not confuse LA with conjugated linoleic acid (CLA). While most think CLA and LA are interchangeable, they're not. CLA has many potent health benefits and will not cause the problems that LA does.

How Excess LA Consumption Damages Your Health

At a molecular level, excess LA consumption damages your metabolism and impedes your body's ability to generate energy in your mitochondria. There is a particular fat only located in your mitochondria – most of it is found in the inner mitochondrial membrane – called cardiolipin.

Cardiolipin is made up of four fatty acids, unlike triglycerides which have three, but the individual fats can vary. Examples include LA, palmitic acid and the fatty acids found in fish oil, DHA and EPA. Each of these have a different effect on mitochondrial function, and depending on the organ, the mitochondria work better with particular kinds of fatty acids.

For example, your heart preferentially builds cardiolipin with LA, while your brain dislikes LA and preferentially builds cardiolipin in the mitochondria with fats like DHA. Goodrich further explains:

"To give you an idea of how important this is, 20% of the fat in your entire body is contained in cardiolipin. So, for anybody who doesn't understand mitochondria, mitochondria are what distinguish us from bacteria. It's what allows us to be a multi-cellular creature. They are what produce the energy in your body, what's known as ATP, which is a chemical carrier of energy.

To give you an example of how important it is, cyanide, which we all know is highly toxic, breaks your mitochondria, and that's why it kills you so fast. It prevents mitochondrial respiration and therefore your entire body shuts down almost instantly.

So, [mitochondria are] something we want to take good care of because they're everywhere, in almost every tissue except for red blood cells ... There are studies showing that cardiolipin is directly controlled by dietary intake of fats. That is, to an extent, true. Obviously, different tissues build cardiolipin in the mitochondria out of different fats.

But they can vary that composition in fairly short order through changing the diet in rat models, like in the order of weeks. So, you can see changes pretty quickly. I notice things happening in days. What's unique about LA is that it is very susceptible to oxidation when it is in the cardiolipin molecule.

Two LAs that are adjacent to each other can oxidize each other. They're also attached to proteins in the mitochondria that contain iron, and that iron can

catalyze the oxidation of cardiolipin. This is a pretty fundamental process in the body."

Oxidation of Cardiolipin Controls Autophagy

Oxidation of cardiolipin is one of the things that controls autophagy. In other words, it's one of the signals that your body uses when there's something wrong with a cell, triggering the destruction and rebuilding of that cell. Your cells know that they're broken when they have too many damaged mitochondria, and the process that controls this is largely the oxidation of omega-6 fats contained within cardiolipin.

“ Animals typically develop cancer once the LA in their diet reaches 4% to 10% of their energy intake, depending on the cancer.”

So, by altering the composition of cardiolipin in your mitochondria to one that's richer in omega-6 fats, you make it far more susceptible to oxidative damage. Goodrich cites research showing that when the LA in cardiolipin is replaced with oleic acid, another fat found in olive oil, the cardiolipin molecules become highly resistant to oxidative damage.

"That is basically what I think we need to go back to," he says. "We evolved with low levels of LA in our diet and therefore in our cardiolipin. One of the neatest papers I've ever seen looking at this, something that encapsulated this whole model that I'm talking about, fed rats either a regular high carbohydrate diet, or they added PUFAs to their diet.

Just adding the omega-6 fats to the diet caused the mice to become diabetic. They became insulin resistant, leptin resistant, obese, and the differences are pretty stark between the fat mice and the skinny mice on the high carbohydrate rat diet ...

The high-PUFA diet caused a breakdown in the cardiolipin content in the mitochondria in their hearts. So just adding seed oils caused heart damage through a change in the cardiolipin composition."

As mentioned, the primary problem is the OXLAMS, the oxidized byproducts. One of them is 4HNE, which is relatively easy to measure. Studies have shown there's a definite correlation between elevated levels of 4HNE and heart failure. LA is broken down into 4HNE even faster when the oil is heated, which is why cardiologists recommend avoiding fried foods.

OXLAMS Trigger Cancer

Heart disease isn't the only condition triggered by excessive LA intake and the subsequent OXLAMS produced. It also plays a significant role in cancer. As noted by Goodrich, to induce cancer in animal models, you actually have to feed them seed oils. "So, this is a really fundamental process that we're talking about here," he says.

As I mentioned above, animals typically develop cancer once the LA in their diet reaches 4% to 10% of their energy intake, depending on the cancer. In the breast cancer model, cancer incidents increase once 4% of calories are in the form of seed oils.

Disturbingly, most Americans get approximately 8% of their calories from seed oils. "So, we're way over what these thresholds in the lab would suggest is a safe level of these fats based on the laboratory work in animals," Goodrich says, adding:

"We've got this huge disconnect between what the lab science tells us we should be doing and what our dietary guidelines tell us we should be doing. The scientists are saying, 'Oh, look, it's poison. It causes all the chronic diseases,' and the government's saying, 'Eat lots of it.' That's not a good thing."

4HNE is a mutagen, in other words, a toxin that causes DNA damage. One of the primary genes it damages is the P53 anticancer gene. Mutations in the P53 gene are found in 15% of cancers, making it one of the most common. As noted by Goodrich, "P53 is literally a cancer prevention gene. It's how your body regulates cancer. You can all draw

your own conclusions about the wisdom of eating something that can cause that to break."

On a side note, one of the major jobs of glutathione is to detoxify 4HNE. You can often tell that you have excess 4HNE if your glutathione levels are low, as this means it's being used up detoxifying 4HNE.

LA and Obesity

High-LA diets also cause obesity. "If you feed mice lots of saturated fat, they don't get fat and they don't get sick. It's only when you increase the LA in the diet from 1% to 8% that they become obese," Goodrich says. Now, mice and rats are not exactly like humans, so how do we know all of this applies to us? Goodrich explains:

"What Alheim and Ramston observed is that, back in 2006, there was a drug introduced called Rimonabant, which was an anti-obesity drug. It was a bit of a miracle drug. I want to quote this exactly because it's so important to understand the effects that this drug had on humans.

'Large randomized trials with Rimonabant have demonstrated efficacy in treatment of overweight and obese individuals with weight loss significantly greater than a reduced calorie diet alone.

In addition, multiple other cardiometabolic parameters were improved in the treatment groups, including increased levels of HDL, reduced triglycerides, reduced weight circumference, improved insulin sensitivity, decreased insulin levels. And in diabetic patients, improvements in HBA1C.'

This paper was released in 2007. Unfortunately, Rimonabant had a side effect that it caused people to want to kill themselves. So, it was withdrawn from the market and it largely killed research for several years into that area.

But what Alheim did in 2012 was demonstrate that the mechanism behind Rimonabant is to block the metabolism of seed oils into the chemicals in your

body and the endocannabinoid system that cause overeating. My experience when I stopped eating seed oils was that I forgot to eat carbohydrates.

The effect of Rimonabant in these mouse models is to make them crave carbohydrates and to stimulate them to eat sweet foods and carbohydrates. Everybody's familiar with this effect. It's called the munchies. And it's what you get after you smoke pot, because the endocannabinoid system is the system that marijuana affects and the chemical that Rimonabant blocks is your body's homologue to the THC in marijuana.

So essentially what we've done to ourselves is given ourselves a chronic case of the munchies, which is blocked by this unfortunately very harmful drug. This is as open and closed a case for causation as you're going to find in the medical literature.

We have a human drug that treats this, and as I just read, it treats all these different aspects of this disease. And it works through this one pathway that we have a clear demonstration of in animal models. In this case, the drug is completely pointless because the dietary fix is well known and is simple."

Increased LA Also Increases Your Risk of Sunburn

So, to summarize, the dramatic increase in LA – and the oxidative end products that cause the damage – is the primary cause behind the increase in chronic diseases such as obesity, diabetes, heart disease and cancer.

Simply lowering your LA intake to what your great-great grandparents used to eat, you can essentially eliminate almost every single one of the diseases that are now prematurely killing us.

Interestingly enough, there's even evidence showing eliminating seed oils from your diet will dramatically reduce your risk of sunburn, which is something Goodrich experienced first-hand. "Susceptibility to UV radiation damage is controlled by how much PUFAs are

in your diet," he says. "It's like a dial. They can control how fast it happens, and how fast you get skin cancer."

Seed Oils Raise Risk of ARDS and COVID-19

Considering the metabolic and mitochondrial damage caused by LA, there's reason to suspect LA may also play a role in COVID-19, as some white blood cells convert LA into leukotoxin. Essentially, LA contributes to the inflammatory domino effect that eventually kills. Goodrich explains:

"Yes. That's certainly what the conclusion that I drew. I did an enormous post on this, looking at the effects of LA in SARS COV-2 and SARS in general. SARS is a severe acute respiratory syndrome. SARS kills you by giving you acute respiratory distress syndrome (ARDS).

ARDS can be caused by lots of different things, not just these viruses. You can get it from influenza. You can get it from inhaling acid into your lungs. What's fascinating is the human literature is quite clear that you can induce ARDS through feeding seed oils.

Very sick people who can't eat are fed intravenously. It's called total parenteral nutrition (TPN). Generally, this is used through a product called Intralipid, which is made out of soybean oil and sugar. When you start to understand all this stuff, it's just mind boggling. Doctors did an experiment after they noticed that a lot of their patients who came into the ICU and got TPN then subsequently got ARDS.

So, they started playing with what they were feeding them, and what they discovered was this soybean oil formula increased the patient's rate of getting ARDS. The fatality rate from ARDS is 30% to 60%. Feeding seed oils increased the rate of ARDS by seven times."

As explained by Goodrich, the key toxin that produces the symptoms of ARDS is called leukotoxin, and leukotoxin is made from LA by white blood cells to kill pathogens. It's

toxic enough to where if you inject high-enough amounts of it into animals, it kills them in minutes. Leukocytes incubated with LA convert all of the LA into this toxin until there's none left, so, a major part of the disease process in ARDS is the conversion of LA into leukotoxin. That is what ends up killing patients.

"It is often noted in the popular press that what kills people is this cytokine storm. What I'm describing is the mechanism of the cytokine storm. Leukotoxin is uniquely what causes the symptoms of ARDS, as has been clearly demonstrated in the animal models," Goodrich says. "So, it seems to me that a sensible thing to do would be [to] change your diet. Why wouldn't you want to do that?"

How LA Triggers Heart Disease

Goodrich also explains how high LA levels cause heart disease. One of the first things that happens in atherosclerosis is your macrophages, another type of leukocyte, turns into a foam cell, essentially a macrophage stuffed with fat and cholesterol.

Atherosclerotic plaque is basically dead macrophages and other types of cells loaded with cholesterol and fat. This is why heart disease is blamed on dietary cholesterol and fat.

However, researchers have found that in order for foam cells to form, the LDL must be modified through oxidation, and seed oils do just this. Seed oils cause the LDL to oxidize, thereby forming foam cells. LDL in and of itself does not initiate atherosclerosis. LDL's susceptibility to this oxidative process is controlled by the LA content of your diet.

"That's a result that's been repeated several times, so subsequently, the definition of an atherogenic lipid in your blood is one that contains oxidized omega-6 fats. That's the definition," Goodrich says.

"The standard explanation of why you get heart disease and why it progresses the way it does is because the omega-6 fats in your blood get oxidized and

become toxic, and progress you all the way through atherosclerosis until it finally kills you.

That's the standard explanation for what causes heart disease. I can't tell you how many cardiologists I have talked to who don't understand that that's what the medical literature says is causing this disease.

Now, it's worse if you're also on a high carbohydrate diet. A ketogenic diet is somewhat protective against the negative effects of this, but I can't stress enough that this is the standard explanation for cardiovascular disease in the medical literature – that seed oils oxidize and that's what causes the pathology."

Understanding Olive Oil

As mentioned, olive oil also contains LA, but it also has other healthy fats. This makes olive oil a bit tricky. The main fat in olive oil is oleic acid, which is one of your body's favorite fats. Your body actually makes it, which is why it's not considered an essential fat. Oleic acid is much more resistant to oxidation than LA, which is why olive oil is a pretty decent cooking oil.

According to Goodrich, oleic acid is protective against both cardiolipin oxidation and LDL oxidation. Interestingly, oleic acid can also replace LA in LDL. Other fats, such as palmitic acid, cannot do that. The problem with olive oil is that it also has a fair amount of LA.

"The percentages that I've seen quoted in literature range from 2%, which is awesome, to 22%, which is not good," Goodrich says. The other problem is the olive oil market is hugely corrupt and fraught with fraud. Many olive oils are cut with cheaper seed oils, which raises the LA content.

So, in summary, if you're using olive oil, I strongly recommend keeping close track of your total LA intake. Anything over 10 grams a day is likely to be problematic (although the exact cutoff is still unknown, so this is merely an educated guess).

If you really want to be on the safe side, consider cutting LA down to 2 or 3 grams per day, to match what our ancestors used to get before all of these chronic health conditions became widespread. If olive oil puts you over the limit, consider cooking with tallow or lard instead. Beef tallow is 46% oleic acid and lard is 36% oleic acid.

High-LA Sources to Avoid

As Goodrich suggests, if you want to protect your health, you'd be wise to avoid all concentrated sources of LA. Top sources include chips fried in vegetable oil, commercial salad dressings, virtually all processed foods and any fried fast food, such as french fries.

"What amazes me is people who go to all these measures and I'll hold up my girlfriend as an example. She was a vegan when we got together, had a farm and grew organic food and went to extremes to avoid toxins in food and then went home and cooked with seed oils," Goodrich says.

"There are so many people who are like this, who are genuinely trying to do their best to have a healthy diet and then they're chugging down LA that turns into a metabolic toxin in your body, and they wonder why they can't lose weight.

By the way, after I told her, what I just said here: Avoid seed oils, avoid refined carbohydrates, eat animal food and animal fats, she lost 56 pounds in two and a half months and her autoimmune disease, fibromyalgia, went into complete remission."

The Importance of Carnosine

Beef, even conventional grain-finished beef, has low LA. Grass fed beef has higher DHA and CLA, which makes it a healthier option. Beef is also the primary source of carnosine, which has been shown to be anti-atherogenic.

Carnosine is also a mitochondrial stimulant, a sacrificial scavenger of advanced lipoxidation end products (ALEs), which is very similar to advanced glycation end

products (AGEs). AGEs is another name for HNE and all the other reactive oxygen species generated from oxidizing LA.

Carnosine is the most effective scavenger for HNE. Carbonylation of proteins is basically the process through which proteins in your body get damaged and become ineffective. HNE damages 24% of the proteins in your cells, so carnosine can go a long way toward warding off this cellular damage. As explained by Goodrich:

"In heart failure, Alzheimer's and in AMD, one of the things they see is an inability of the cell to produce enough energy. The mitochondria are getting damaged. HNE does that damage. It damages 24% of the proteins in the cell, primarily around energy production.

One of the worst cancers is glioblastoma, a brain cancer. A researcher up in Boston, [Thomas Seyfried], decided to try and figure out why the mitochondria are getting damaged in glioblastoma, and found they all have oxidized cardiolipin. Every single cancer cell he looked at had damaged cardiolipin in it.

One of the ways your cells produce energy is they basically ferment glucose into pyruvate outside of the mitochondria. This is a perfectly normal part of metabolism and they produce something called pyruvate. A molecule called pyruvate dehydrogenase takes pyruvate into the mitochondria and converts it to acetyl-CoA so the mitochondria can burn it very efficiently for fuel.

Well, one of the things HNE does is it breaks pyruvate dehydrogenase, and they see this in Alzheimer's where their cells are no longer able to produce enough energy. This is why your cells are dying in Alzheimer's. The beta amyloid plaques in Alzheimer's disease are induced by HNE. There's a great model that came out of Harvard a couple of years ago showing that.

And in cancer, if you can't get pyruvate out of the cell, out of the cytosol, the part of the cell surrounding the mitochondria, it has to ferment there and turn it into energy, which is what we call the Warburg effect, where you start shifting over to this damaged primitive fuel system. The evidence seems to be that that's because you've broken your mitochondria.

Even the critical, the most important part of the mitochondria, complex 5ADP synthase – which is what takes all the energy coming from your mitochondria and turns it into ATP, which is what fuels the rest of your body – is damaged by HNE. This is a huge issue. There's no more fundamental problem in aging and health than protein damage."

Take Control of Your Health by Lowering Your LA Intake

As you can see, the evidence strongly suggests excessive LA is driving all the killer diseases today. The solution is simple though. Just lower your LA intake. There's an easy way to do this. You don't have to send all your food out for analysis. Simply use an online nutritional calculator such as Chronometer to calculate your daily intake.

Chronometer will tell you how much omega-6 you're getting from your food down to the 10th of a gram, and you can assume 90% of that is LA. Again, anything over 10 grams is likely to cause problems. Since there's no downside to limiting your LA, you'll want to keep it as low as possible, which you do by avoiding high-LA foods.

Keep in mind you'll never be able to get to zero, and you wouldn't want to do that either. So, just what should you eat to keep your LA intake low? Goodrich summarizes his own diet:

"I eat mostly beef. I eat vegetables. I cook mostly in butter. I eat a little bit of fruit. I eat occasional grains. Occasionally I'll have corn, a little bit of rice and potatoes. I'm mostly on a cyclical keto diet. Once you fix your metabolic system, then you can go back and forth a lot easier and I don't see any reason to be on strict keto long term. I think [cyclical keto] is healthier."

They looked at a ketogenic diet in rodents and found they were protected. The reason they were protected is because they were able to burn HNE as fuel. But if you add a little bit more insulin into the system, then it turns off fat-burning and HNE goes out of the mitochondria and does more damage."

This is yet another reason for working out in a fasted state, which Goodrich also recommends. "I think working on a fasted state is one of the most important health things that you can do, without question," he says. Goodrich also points out that the reason a strict ketogenic diet can cause liver failure is due to the omega-6 fats in the diet. It's crucial to make sure the fats you eat are actually healthy.

Goodrich is currently in the process of writing a book about this, as am I, in which all of this information will be laid out in even greater detail. In the meantime, you can learn more by visiting Goodrich's blog, [Yelling-Stop](#), or [follow him on Twitter](#). In closing:

"I can't say anything that you haven't already said in this talk, honestly," Goodrich says. "You want to eat like your ancestors ate because your ancestors were healthier and they were not eating industrial seed oils. They were not eating industrial processed carbs in high quantities.

They were making sure that they got lots of animal meat and animal fat and they were getting exercise. I mean, it doesn't really matter what kind of exercise you're doing, just as long as you're doing it.

I think I have helped many people in many different ways by telling people this. And it's typically a short conversation, like my girlfriend who cured her autoimmune disease, fibromyalgia. She'd been in constant pain for almost 30 years and it went away in a couple of weeks. I mean, that's amazing, and it's so simple to do.

This is, I believe, the fundamental problem with our modern health – this issue of LA. There are lots of other things that play into it. There's no doubt about that, but that's the fundamental thing. If you fix that, you can get away with doing a lot of other things that aren't exactly optimal, but still be healthy."