

# Ketogenic Diet Protects Against Alzheimer's Disease by Keeping Your Brain Healthy and Youthful

## STORY AT-A-GLANCE

- Recent animal research shows a ketogenic diet improves neurovascular function, in part by improving your gut microbiome
- Compared to animals given regular chow, rodents fed a ketogenic diet for 16 weeks were found to have significant increases in cerebral blood flow and improved clearance of amyloid-beta and reduced mTOR activation
- Rodents fed a ketogenic diet also had greater abundance of beneficial gut bacteria and reduced amounts of proinflammatory microbes, increased ketone levels, reduced blood glucose and lower body weight, all of which improve neurological function and lower risk for Alzheimer's
- Insulin resistance is strongly linked to Alzheimer's disease, the most severe form of dementia. Alzheimer's is sometimes referred to as Type 3 diabetes
- A ketogenic diet is high in healthy fats and low in net carbohydrates, which allows your body to burn fat as its primary fuel rather than sugar, which helps optimize mitochondrial function and biological regeneration

Alzheimer's disease — the most severe form of dementia — is proving to be stubbornly resistant to conventional remedies. More than 190 human drug trials have ended in failure,<sup>1</sup> and despite a burgeoning epidemic, the best drugs on the market only ameliorate symptoms while adding other health risks.

At present, the best conventional medicine can really hope for is improved diagnosis, which is why prevention is so crucial. Mounting research suggests your diet is indeed a foundational driver of this disease, and an effective prevention strategy.

Perhaps the most important dietary factor that impacts your Alzheimer's risk is the amount of net carbs (total carbs minus fiber) you consume on a regular basis. A high-sugar diet triggers insulin resistance — currently thought to affect as many as 8 in 10 Americans<sup>2,3</sup> — and there's a very strong link between [insulin resistance](#) and Alzheimer's.<sup>4</sup>

For example, a longitudinal study<sup>5</sup> published in the journal *Diabetologia* in January 2018, which followed nearly 5,190 individuals for over a decade, found that the higher an individual's blood sugar, the faster their rate of cognitive decline.

Even mild elevation of blood sugar and mild insulin resistance are associated with an elevated risk for [dementia](#).<sup>6,7</sup> [Diabetes](#) and [heart disease](#)<sup>8</sup> are also known to elevate your risk, and both are rooted in insulin resistance.

One of the most striking studies<sup>9</sup> on carbohydrates and brain health revealed high-carb diets increase your risk of dementia by 89 percent, while high-fat diets lower it by 44 percent. According to the authors:

*“A dietary pattern with relatively high caloric intake from carbohydrates and low caloric intake from fat and proteins may increase the risk of mild cognitive impairment or dementia in elderly persons.”*

## **Nutritional Ketosis Protects and Supports Healthy Brain Function**

A ketogenic diet is high in [healthy fats](#) and low in net carbohydrates, and one of the primary benefits of this kind of diet is that it allows your body to start burning fat as its primary fuel rather than sugar.

When your body burns fat as its primary fuel, ketones are created, which not only burn very efficiently and are a superior fuel for your brain, but also generate fewer reactive oxygen species (ROS) and less free radical damage. But that's not all.

A type of ketone called beta-hydroxybutyrate is also an important epigenetic player, having significant effects on DNA expression, increasing detoxification pathways and your body's own antioxidant production. Beta-hydroxybutyrate also stimulates specific receptors on cells called G-proteins.

When these receptors are tagged by this beta-hydroxybutyrate during mild ketosis, it helps reduce the activation of pathways that lead to inflammation, and inflammation is a driver in most all chronic diseases, be it Alzheimer's, heart disease, diabetes or cancer. So, it's not merely about powering your cells with fat.

A ketogenic diet also helps alter your metabolism, thereby paving the way for health. The [benefits of nutritional ketosis](#) for brain health were again demonstrated in two recent papers — an animal study and a scientific review.<sup>10,11,12,13,14</sup>

In the first paper, researchers found that this kind of diet improves neurovascular function, in part by improving the gut microbiome. In the second paper, they concluded the ketogenic diet acted as a veritable “fountain of youth” for aging rodents, significantly improving neurovascular and metabolic functions in the animals, compared to those eating an unrestricted diet.

## **How a Ketogenic Diet Protects Against Alzheimer's Disease**

As noted in the first study,<sup>15</sup> published in Scientific Reports, “Neurovascular integrity, including cerebral blood flow and blood-brain barrier function, plays a major role in determining cognitive capability.”

More specifically, poor neurovascular function is strongly associated with loss of language, memory and attention, while reduced cerebral blood flow raises your risk for depression, anxiety and dementia. Impaired blood-brain barrier function has also been linked to inflammation in the brain, dysfunction of synapses, impaired clearance of amyloid-beta plaques, psychiatric disorders and dementia.<sup>16</sup>

“Interventions that maintain gut microbiome and neurovascular integrity may thus be crucial for impeding neurological disorders,” Ai-Ling Lin and her colleagues at the Sanders-Brown Center on Aging at the University of Kentucky note.<sup>17</sup>

Recent studies have demonstrated that your gut microbiome can play a significant role in neurovascular integrity, so here they sought to determine whether a ketogenic diet might have a beneficial impact on the gut microbiome, thereby enhancing neurovascular function and reducing the risk of neurodegeneration in mice.

Previous studies have also demonstrated that a ketogenic diet can benefit those suffering traumatic brain injury, ischemic stroke and [autism](#), likely by way of altering your gut microbiome.

“Collectively, [a ketogenic diet] may be protective against various neurological disorders, possibly through the restoration of neurovascular function and by maintaining healthy gut microbiome,” the authors note. The present study adds further support to this hypothesis. Compared to animals given regular chow, rodents fed a ketogenic diet for 16 weeks were found to have:

**Significant increases in cerebral blood flow**

**Significant increase in P-glycoprotein transports on the blood brain barrier**, which improves clearance of amyloid-beta, a main component of the plaque that accumulates in the brains of those with Alzheimer’s disease

**Reduced mechanistic target of rapamycin (mTOR)**, which is associated with the promotion of general health, a lower risk of cancer and extension of life span

**Increased endothelial nitric oxide synthase (eNOS) protein expression**

**Increased relative abundance of the beneficial gut microbiota** Akkermansia muciniphila (2.5fold increase) and Lactobacillus (3.2fold increase), both of which produce short-chain fatty acids (SCFAs) that ferment dietary fiber and nourish colonic cells, thereby lowering your risk for [bowel inflammation](#). According to the authors, lack of SCFAs can also increase blood-brain-barrier permeability

**Reduced abundance of the proinflammatory microbes** Desulfovibrio and Turicibacter. Desulfovibrio was completely absent in treated mice, and these microbes are also known to impair the gut barrier

**Increased blood ketone levels**, and recent research<sup>18</sup> shows the cerebral metabolic rate of ketones represents about one-third (33 percent) of the brain’s energy requirement after four days on a ketogenic diet

**Reduced blood glucose levels**, possibly due to an increase in Akkermansia muciniphila. Previous research has

shown that *A. muciniphila* increases when Type 2 diabetics are given metformin, medication that increases glucose utilization by activating the MP-activated protein kinase (AMPK) pathway. *A. muciniphila* is also associated with increased insulin sensitivity and weight loss

**Lower body weight**, possibly due to increases in *Lactobacillus*, which have been linked to weight loss and improved loss in several studies. As noted by the authors:<sup>19</sup>

*“Being able to maintain proper body weight and blood glucose level is crucial for reducing risk for Alzheimer’s disease, which is known as Type 3 diabetes with increased glucose intolerance in the brain ...*

*Recent advances indicate that excessive white fat increases secretion of pro-inflammatory cytokines from adipocytes, which could consequently lead to neuroinflammation, amyloid-beta retention, brain cell death and dementia ...*

*Furthermore, ketogenic diet improves hippocampal glycolytic and tricarboxylic acid cycle intermediates and amino acid in a 3xTgAD mouse model, suggesting that ketogenic diet may also improve insulin sensitivity in the brain. It indicates that ketogenic diet-induced body weight loss may evoke metabolic and immune function changes that potentially lead to neuroprotective effects”*

According to the authors, “Our findings suggest that ketogenic diet intervention started in the early stage may enhance brain vascular function, increase beneficial gut microbiota, improve metabolic profile, and reduce risk for Alzheimer’s disease.” Lin also told Eurekalert,<sup>20</sup>

*“While diet modifications, the ketogenic diet in particular, has demonstrated effectiveness in treating certain diseases, we chose to test healthy young mice using diet as a potential preventative measure. We were delighted to see that we might indeed be able to use diet to mitigate risk for Alzheimer’s disease.”*

## Neuroimaging Sheds Light on How Ketogenic Diet Affects the Brain

In a follow-up paper<sup>21</sup> published in the journal *Frontiers in Aging Neuroscience*, Lin’s team discusses the neuroprotective effects of mTOR inhibition in Alzheimer’s disease and aging by looking at recent studies using neuroimaging techniques to evaluate the effects of three interventions — rapamycin (an mTOR inhibitor), the ketogenic diet and simple caloric restriction — on the living brain.

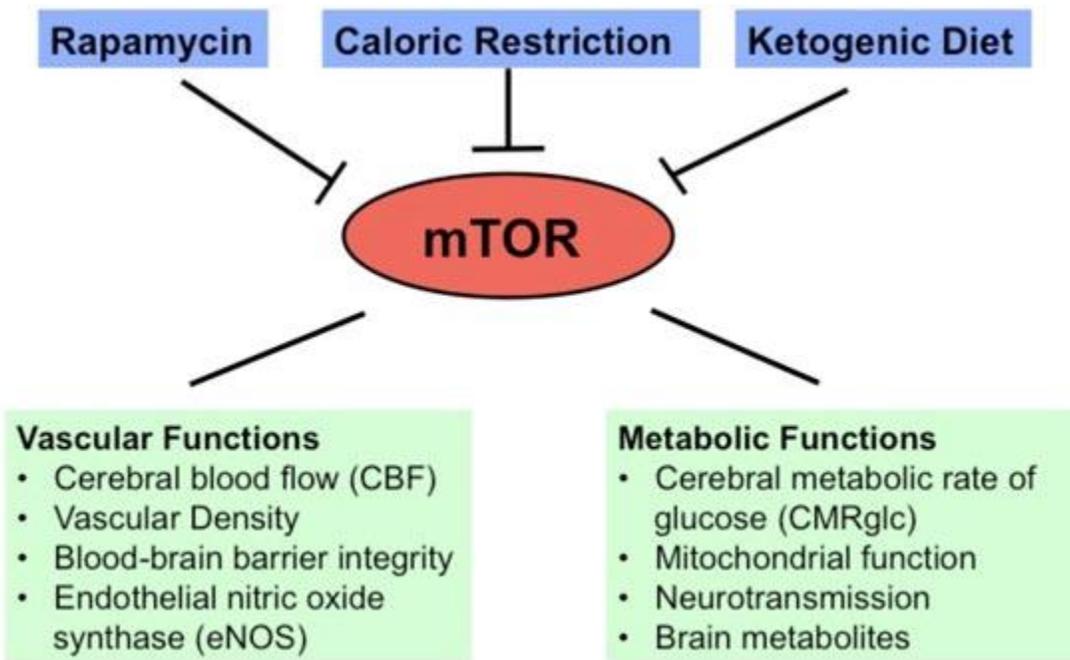
Both rapamycin administration and caloric restriction have previously been shown to inhibit mTOR — a protein bound by rapamycin — thereby increasing health and life span in a number of different species.

Inhibiting mTOR has also been shown to protect against age- and disease-related neurodegeneration by improving and preserving mitochondrial function and inhibiting the retention of amyloid beta in the brain.<sup>22</sup> “Notably, rapamycin reduces amyloid-beta plaques and neurofibrillary tau tangles and improves cognitive functions in mice that model human Alzheimer’s disease,” the authors state.

To assess the impact of mTOR inhibition in vivo, studies have used a number of different magnetic resonance imaging methods, including angiography, spectroscopy, confocal microscopic imaging and positron emission tomography (PET). In summary, the authors conclude that:

*“... [R]apamycin is a preventative, and possibly a treatment, for the effects of the [Alzheimer’s disease] phenotype observed in APOE4 and hAPP(J20) transgenic mouse models of [Alzheimer’s disease]; [caloric restriction] and [ketogenic diet] can enhance brain vascular functions and shift metabolism in young healthy mice; and [caloric restriction] can preserve brain metabolic and vascular functions in aging.*”

*We summarize these findings in Figure 1<sup>23</sup> [see below]. As the quantitative PET and MRI neuroimaging methods used in these studies in animal models can be translated into human studies, they will be greatly useful in future studies to examine the effects of these mTOR-related interventions in preventing brain function declines associated with aging and neurodegeneration in clinical trials.”*



Lin and her colleagues are now designing a clinical trial to further investigate how the human gut microbiome influences neurovascular dysfunction, which is a known risk factor for Alzheimer’s, in otherwise healthy adults. Lin told Eurekalert:<sup>24</sup>

*“We will use neuroimaging to identify the association between gut microbiome balance and brain vascular function in individuals over 50 years of age, with an ultimate goal to design and test nutritional and pharmacological interventions that will prevent Alzheimer’s disease.”*

## **Sugar Atrophies Your Hippocampus, Impairing Memory**

While the ketones produced in response to a high-fat (ketogenic) diet are an ideal source of brain fuel, research<sup>25</sup> published in 2013 showed that sugar and other carbohydrates can disrupt your brain function even if you're not diabetic or have any signs of dementia.

Here, short- and long-term glucose markers were evaluated in healthy, nondiabetic seniors without dementia. Memory tests and brain imaging were also used to assess brain function and the actual structure of their hippocampus. The findings revealed that the higher the two blood glucose measures, the smaller the hippocampus, the more compromised its structure, and the worse the individual's memory was.

According to the authors, the structural changes in the hippocampus alone can partially account for the statistical link we see between glucose and memory, as your hippocampus is involved with the formation, organization and storage of memories.

The results suggest glucose directly contributes to atrophy of the hippocampus, which means that even if you're not insulin resistant or diabetic, excess sugar may still be negatively affecting your memory. The authors suggest that "strategies aimed at lowering glucose levels even in the normal range may beneficially influence cognition in the older population."

A similar study<sup>26</sup> published in 2014 found that Type 2 diabetics lose more gray matter with age than expected, and this brain atrophy also helps explain why diabetics have a higher risk for dementia, and have earlier onset of dementia than nondiabetics.

As noted by Dr. Sam Gandy, director of the Center for Cognitive Health at Mount Sinai Hospital in New York City, these findings "suggest that chronic high levels of insulin and sugar may be directly toxic to brain cells" adding that "This would definitely be a potential cause of dementia."<sup>27</sup>

## **Prevention and Early Detection Are Key to Stem Dementia Tide About to Overtake Us**

According to a report by the Alzheimer's Association,<sup>28</sup> the U.S. spends about \$277 billion on dementia care each year,<sup>29,30</sup> and that doesn't include care by unpaid caregivers. About 70 percent of these costs are paid by the families through out-of-pocket expenses.

On average, the out-of-pocket expenses for caregivers of someone with dementia are \$10,697 per year, and 40 percent of caregivers have an annual household income below \$50,000. By 2050, we may be looking at a health care bill of \$1.1 trillion per year to take care of our seniors with dementia.

Considering 5.7 million Americans currently have Alzheimer's and prevalence is projected to rise nearly 29 percent in the next seven years alone, it would behoove everyone to take prevention seriously, and begin taking proactive steps sooner rather than later. For while

the financial costs may be steep, no price can be placed on the emotional and psychological costs associated with this tragic disease.

That said, early detection can certainly be helpful, and strides are being made in the development of a blood test to detect Alzheimer's.<sup>31</sup> In a recent trial,<sup>32</sup> the test was 90 percent accurate in detecting the disease in a pool of 370 participants.

One of the most comprehensive assessments of Alzheimer's risk is Dr. Dale Bredeesen's ReCODE protocol, which evaluates 150 factors known to contribute to the disease. This protocol also identifies your disease subtype or combination of subtypes so that an effective treatment protocol can be devised. You can learn more about this in "[ReCODE: The Reversal of Cognitive Decline](#)."

The full protocol is described in Bredeesen's book, "The End of Alzheimer's: The First Program to Prevent and Reverse Cognitive Decline."<sup>33</sup> However, if you're diagnosed with early warning signs, that still means you're on your way toward Alzheimer's, and it didn't need to get to that point in the first place.

As with cancer, early detection should not be confused with prevention, as diagnosing does not prevent you from having to figure out how to reverse the damage. Based on what we currently know, it seems foolish in the extreme to ignore dietary factors, and a key consideration is to reduce your net carb consumption and increase healthy fats.

According to Dr. David Perlmutter, a neurologist and author of "Grain Brain" and "Brain Maker," anything that promotes insulin resistance will ultimately also raise your [risk of Alzheimer's](#). As a general rule, you'll want to keep your fasting insulin level below 3 uIU/mL. (As a reference range, the corresponding fasting glucose level for this number would be below 75 mg/dL.)<sup>34</sup>

To this I would add that any strategy that enhances your mitochondrial function will lower your risk. Based on the evidence, I believe the [cyclical ketogenic diet](#) I describe in my book "[Fat for Fuel](#)" can go a long way toward avoiding neurological degeneration by optimizing your mitochondrial function and biological regeneration.

## Other Helpful Prevention Strategies

Aside from adopting a cyclical ketogenic diet, focused on whole food (opposed to processed fare), following are several other lifestyle strategies I believe to be helpful and important when it comes to preventing the neurodegeneration associated with Alzheimer's:

**Optimize your omega-3 level** — High intake of the omega-3 fats EPA and DHA help prevent cell damage caused by Alzheimer's disease, thereby slowing down its progression and lowering your risk of developing the disorder. Ideally, get an omega-3 index test done once a year to make sure you're in a healthy range. Your omega-3 index should be above 8 percent and your omega 6-to-3 ratio between 0.5 and 3.0.

**Optimize your gut flora** — To do this, avoid processed foods, antibiotics and antibacterial products, fluoridated and chlorinated water, and be sure to eat traditionally fermented and cultured foods, along with a high-quality probiotic if needed. Dr. Steven Gundry does an excellent job of expanding on this in his book “[The Plant Paradox](#).”

**Intermittently fast** — [Intermittent fasting](#) is a powerful tool to jump-start your body into remembering how to burn fat and repair the insulin/leptin resistance that is a primary contributing factor for Alzheimer’s. Once you have worked your way up to where you’ve been doing 20-hour daily intermittent fasting for a month, are metabolically flexible and can burn fat as your primary fuel, you can progress to the far more powerful five-day water fasts.

**Move regularly and consistently throughout the day** — It's been suggested that exercise can trigger a change in the way the amyloid precursor protein is metabolized,<sup>35</sup> thus, slowing down the onset and progression of Alzheimer's. Exercise also increases levels of the protein PGC-1 alpha. Research has shown that people with Alzheimer's have less PGC-1 alpha in their brains and cells that contain more of the protein produce less of the toxic amyloid protein associated with Alzheimer's.

**Optimize your magnesium level** — Preliminary research strongly suggests a decrease in Alzheimer symptoms with [increased levels of magnesium in the brain](#). Keep in mind that the only magnesium supplement that appears to be able to cross the blood-brain barrier is magnesium threonate.

**Optimize your vitamin D, ideally through sensible sun exposure** — Sufficient [vitamin D](#) is imperative for proper functioning of your immune system to combat inflammation associated with Alzheimer's and, indeed, research shows people living in northern latitudes have higher rates of death from dementia and Alzheimer's than those living in sunnier areas, suggesting vitamin D and/or sun exposure are important factors.<sup>36</sup>

If you are unable to get sufficient amounts of sun exposure, take daily supplemental vitamin D3 to reach and maintain a blood level of 60 to 80 ng/ml. That said, it’s important to recognize that sun exposure is important for reasons unrelated to vitamin D.

Your brain responds to the near-infrared light in sunlight in a process called photobiomodulation. Research shows near-infrared stimulation of the brain boosts cognition and reduces symptoms of Alzheimer’s, including more advanced stages of the disease. Delivering near-infrared light to the compromised mitochondria synthesizes gene transcription factors that trigger cellular repair, and your brain is one of the most mitochondrial-dense organs in your body.

**Avoid and eliminate mercury from your body** — Dental amalgam fillings are one of the major sources of heavy metal toxicity; however, you should be healthy prior to having them removed. Once you have adjusted to following the diet described in my optimized nutrition plan, you can follow the [mercury detox protocol](#) and then find a biological dentist to have your amalgams removed.

**Avoid and eliminate aluminum from your body** — Common sources of aluminum include antiperspirants, nonstick cookware and vaccine adjuvants. For tips on how to detox aluminum, please see my article, “[First Case Study to Show Direct Link between Alzheimer’s and Aluminum Toxicity](#).” There is some suggestion that certain mineral waters high in silicic acid may help your body eliminate aluminum.

**Avoid flu vaccinations** — Most flu vaccines contain both mercury and aluminum.

**Avoid statins and anticholinergic drugs** — Drugs that block acetylcholine, a nervous system neurotransmitter, have been shown to increase your risk of dementia. These drugs include certain nighttime pain relievers, antihistamines, sleep aids, certain antidepressants, medications to control incontinence and certain narcotic pain relievers.

Statin drugs are particularly problematic because they suppress the synthesis of cholesterol, deplete your brain of coenzyme Q10, vitamin K2 and neurotransmitter precursors, and prevent adequate delivery of essential fatty acids and fat-soluble antioxidants to your brain by inhibiting the production of the indispensable carrier biomolecule known as low-density lipoprotein.

**Limit your exposure to dangerous EMFs (cellphones, Wi-Fi routers and modems)** — [Radiation from cellphones and other wireless technologies](#) trigger excessive production of peroxynitrites,<sup>37</sup>a highly damaging reactive nitrogen species.

Increased peroxynitrites from cellphone exposure will damage your mitochondria,<sup>38,39</sup> and your brain is the most mitochondrial-dense organ in your body. Increased peroxynitrite generation has also been associated with increased levels of systemic inflammation by triggering cytokine storms and autonomic hormonal dysfunction.

**Optimize your sleep** — Sleep is necessary for maintaining metabolic homeostasis in your brain. Without sufficient sleep, neuron degeneration sets in, and catching up on sleep during weekends will not prevent this damage.<sup>40,41,42</sup>

Sleep deprivation causes disruption of certain synaptic connections that can impair your brain's ability for learning, memory formation and other cognitive functions. Poor sleep also accelerates the onset of Alzheimer's disease.<sup>43</sup>

Most adults need seven to nine hours of uninterrupted sleep each night. Deep sleep is the most important, as this is when your brain's glymphatic system performs its cleanout functions, eliminating toxic waste from your brain, including amyloid beta.

**Challenge your mind daily** — Mental stimulation, especially learning something new, such as learning to play an instrument or a new language, is associated with a decreased risk of dementia and Alzheimer's. Researchers suspect that mental challenge helps to build up your brain, making it less susceptible to the lesions associated with Alzheimer's disease.