

Benefits of Carnitine

Restores Cellular Function

Research now shows that the amino acid **carnitine** can forestall and even reverse many well-known factors of aging.

With advancing age, carnitine levels decline in all of our tissues.^{2,3} and a *carnitine deficiency* leads to the extensive destruction of our mitochondria. Ultimately, this loss of mitochondrial function is likely to hasten death.

Repairs Mitochondrial Function

The age-related decline in *mitochondrial activity* is largely responsible for cardiovascular and neurological disorders as well as obesity and type II diabetes.⁶⁻⁹ Loss of mitochondrial function in muscle tissue also leads to the familiar “flabby” body composition we associate with older people because it causes muscle atrophy and increased body fat mass.¹⁰

Total carnitine levels in aging individuals are roughly 20% lower than in youth,¹¹ which leaves mitochondria increasingly vulnerable to damage.

Fortunately, studies have proven that supplementing with carnitine can restore mitochondrial function to near-youthful levels.¹²

Reduces Death Rates

The heart muscle uses fat as its primary energy source. Carnitine is a fat-transporting compound that is absolutely essential for normal heart function.¹³ Over time, the decline of carnitine plays a role in the weakening of the heart’s muscles.¹⁴

People with heart muscle damage from heart attacks or heart failure have especially low carnitine levels.¹⁵⁻¹⁷ Carnitine supplementation has proven to be remarkably effective in fighting and even reversing the heart-weakening effects from that drop in carnitine levels.¹⁴

L-carnitine supplementation also prevents the progression of heart muscle damage in people with congestive heart failure and improves exercise tolerance in people who develop chest pain (angina) with exertion. In one study, 55% of patients experienced improvement in their standard heart failure classification.¹⁵

Carnitine also increases concentrations of nitric oxide that help endothelial cells relax and increase blood flow, which can help lower blood pressure.²¹⁻²³

Carnitine for Diabetics and People on Dialysis

Two groups stand to gain exceptional benefits from carnitine supplementation: diabetics and those on dialysis. Both groups are at especially high risk for cardiovascular complications and early death, and both groups have an even greater depletion of carnitine than others of the same age.^{17,26}

Dialysis exerts huge stresses on the human body, all of which accelerate atherosclerosis and heart disease. The addition of a 1-gram, IV dose of L-carnitine at the end of each dialysis session markedly reduced chemical markers of stress and increased levels of the protective cytokine *adiponectin*.²⁶

The same 1-gram dose, given orally, produced a marked reduction in serum inflammatory markers and factors that promote excessive blood clots.²⁷ Finally, a dose of **10 mg/kg** of carnitine (about **750 mg/day** in an average-sized person) produced a significant **12%** decrease in the size of the heart's left ventricle in dialysis patients.²⁸ That "left ventricular hypertrophy" is a known complication of hemodialysis and contributes to early heart failure.

Diabetics suffer from both *ischemic* (low blood flow) and non-ischemic heart muscle dysfunction, much of which can be reduced by long-term oral L-carnitine supplements.²⁹ Animal studies show that whether you're a diabetic or not, oral supplementation with L-carnitine helps your heart muscle pump harder and more efficiently.²⁹ Even more impressive, carnitine's mitochondria-friendly actions help reduce body fat mass, which in turn improves insulin sensitivity and may help control blood sugar levels.^{30,31}

Fights Diabetes and Obesity

Since carnitine helps the mitochondria utilize energy, it plays a critical role in reducing the occurrence and impact of diabetes.³⁴ Recent studies show that in addition to helping the mitochondria burn fat as energy, carnitine is also vital for removing waste products from mitochondria.^{2,35} This is important, because we now recognize that the buildup of mitochondrial waste products is one of the most important contributors to insulin resistance, which further promotes high blood sugar and obesity.⁴

Obesity and aging contribute to low carnitine levels, which compromises mitochondrial performance and increases insulin resistance, promoting further obesity and carnitine reduction.² Restoring carnitine levels to their youthful values is an effective way to break this deadly cycle.²

Human volunteers who took L-carnitine **3 grams/day** for 10 days had favorable changes in body composition.³⁶ Supplemented patients used their fat for energy, burning it **22%** faster than control patients, without any increase in muscle protein breakdown. Another study, using **2 grams/day** for 6 months, demonstrated a loss of total fat mass of **4 pounds**, with a gain in lean muscle mass of **8.4 pounds**.³⁷

Animal studies confirm and extend these findings, showing that L-carnitine decreases body weight gain, food intake, and fat composition, while improving insulin resistance.³⁴

Carnitine also has multiple favorable effects on blood sugar and insulin resistance, the features of type II diabetes.³⁵ Animals fed a high fat diet develop the same symptoms and signs that humans do: obesity, insulin resistance, abnormal lipid profiles, and liver damage which are known as *metabolic syndrome*. Just 4 weeks of treatment with L-carnitine reversed all of those abnormal parameters.^{30,32,38,39}

Similar effects have been found in diabetic humans. Two grams of L-carnitine twice daily for 10 days improved insulin sensitivity and reduced insulin levels.⁴⁰ L-carnitine supplementation of **2 grams/day** caused a significant reduction in plasma free fatty acids, which contribute to insulin resistance.⁴¹ Three grams/day were shown to reduce simulated *after-meal* blood sugar spikes from **157 mg/dL** to **132 mg/dL** (oral glucose tolerance test).⁴² A significant number of studies document the deadly impact of

elevated *after-meal* glucose levels.

Protects Memory

Most forms of age-related memory and cognitive decline are closely related to *mitochondrial dysfunction* in brain tissue. That provides an obvious opportunity for intervention with a mitochondrial enhancer such as carnitine. Most studies of neurodegeneration used the acetyl-L-carnitine form of carnitine.

The impact of acetyl-L-carnitine is especially important in Alzheimer's disease, the leading cause of dementia and mild cognitive impairment in the United States. One early study showed that supplementing with acetyl-L-carnitine every day for a year led to improvements on the cognitive portion of a standard Alzheimer's disease rating scale in patients younger than 61.⁴³

More recent studies have shown good effects even in older patients, but, as with all forms of prevention, the earlier you start taking carnitine, the more powerful the effects on memory. Doses ranging from **1.5 to 3 grams/day** of acetyl-L-carnitine have consistently been shown to produce treatment effects several-fold greater than placebo alone, with the greatest impact in patients in the earlier stages of the disease.⁴⁴⁻⁴⁶ Improvements from acetyl-L-carnitine supplementation can be seen as early as 3 months, and continue to increase over time.⁴⁵ (Carnitine has not been found effective in patients with advanced Alzheimer's.)

Laboratory studies explain some of the reasons for acetyl-L-carnitine's impact on Alzheimer's disease, and most of them focus on carnitine's mitochondrial protective properties.

Scientists can induce Alzheimer's-like changes in brain cells using a variety of chemical techniques, and they consistently find that treatment with acetyl-l-carnitine enhances mitochondrial function and slows development of those changes, which include accumulation of the "Alzheimer's protein" *amyloid beta* (*Abeta*).⁴⁷ Even after dangerous quantities of *amyloid beta* form in brain tissue, acetyl-L-carnitine treatment reduces its impact.³

Lab animals with conditions similar to Alzheimer's disease demonstrate improved memory and learning when treated with acetyl-L-carnitine.^{47,48} In fact, treated animals show increased expression of important memory-associated proteins that had become impaired by Alzheimer's disease.⁴⁹

Acetyl-L-carnitine is useful in other forms of cognitive decline as well, even in poorly-defined conditions such as mild cognitive (or mental) impairment. People supplemented with **1.5 to 2 grams** of acetyl-L-carnitine daily show marked improvement on standard mental status and memory scores.^{50,51}

These effects are especially impressive among the very old, including at least one study of people over 100 years old.³⁷

Benefits Body Composition

Carnitine's influence on mitochondrial function can improve age-induced changes in body composition. When lab animals were given carnitine, they experienced reductions in their abdominal fat mass, increases in their muscle strength, and lower concentrations of *leptin*, a cytokine that triggers fat-induced inflammation.^{10,52}

Human volunteers who took **3 grams/day** of L-carnitine for 10 days had favorable changes in body

composition.³⁶ Patients taking L-carnitine used their fat for energy, burning it **22%** faster than control patients, and without any increase in muscle protein breakdown. Another study using 2 grams/day demonstrated a loss of total fat mass of **4 pounds**, with a gain in lean muscle mass of **8.4 pounds**.³⁷

Additional studies on animals confirm and extend these findings, showing that propionyl-L-carnitine decreases body weight gain, food intake, and fat composition, while improving insulin resistance.³⁴

Benefits of supplementation go well beyond memory, however. Not surprisingly for a **mitochondrial function-boosting** compound, improvements in energy level, and reduction in physical and mental fatigue are commonly reported in studies of carnitine supplementation (both with L-carnitine and acetyl-L-carnitine).^{37,53} And a few studies have found improvements in depression while patients supplement with L-carnitine.^{54,55}

Finally, as a result of the obesity epidemic (and with liver disease and cirrhosis on the rise),⁵⁶ researchers are showing a growing interest in using carnitine to optimize liver mitochondrial function and prevent or mitigate the effects of liver failure. Several studies have demonstrated clinical and biochemical improvements in patients with hepatic encephalopathy, a condition in which rising blood ammonia levels impair cognitive and motor function.⁵⁷⁻⁵⁹

Fights Cancer Wasting

One of the most painful and tragic consequences of many cancers is their induction of *cachexia*, the progressive loss of appetite, energy, and body fat, with increased muscle wasting.^{60,61} Cancer cachexia is induced by many factors, the most prominent of which is decreased tissue carnitine levels.⁶⁰⁻⁶² Diminished appetite contributes to poor nutrition and further declines in carnitine levels.^{63,64}

Many strong studies now demonstrate that the carnitine supplements can reduce the rate and severity of cancer cachexia.^{65,66} Many also show improvements in appetite, fatigue, and quality of life.^{61,67,68}

Summary

Loss of mitochondrial function is a major contributor to the process of aging. It deprives vital tissues in our body of the energy they need to perform normal tasks and to keep us vibrant, healthy, and young. Carnitine, a natural facilitator of energy transport in mitochondria, is essential for keeping mitochondria healthy and preventing their age-related loss.

Supplementing with carnitine can help preserve cell energy levels, reduce fatigue, enhance heart muscle strength, reduce the impact of obesity and diabetes, slow signs of brain aging, and protect heart attack victims from dying.

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