Background

Carnine is the collective term for a number of compounds that include D- and L-carnitine, acetyl-L-carnitine, and propionyl-L-carnitine. Only one form (L-carnitine, but not D-carnitine) is biologically active, i.e., of use to the body. Carnitine plays an important role in fat metabolism: It is required for the breakdown of fatty acids into usable forms. Fatty acids are a major energy source for working muscles, and it has been suggested that increasing the availability of carnitine will increase its rate of absorption and breakdown (via oxidation) in the body’s cells. Proposed ways in which carnitine may enhance performance include improved oxidation of fatty acids in the muscles, altered regulation of glucose, increased production of acylcarnitine (important for carnitine effectiveness), and the ability of muscles to resist fatigue. While levels of L-carnitine in the bloodstream respond to supplementation, the amount of carnitine in muscles, cellular production of carnitine, and physical performance do not appear to do so. Recent data, however, suggest that the reserves of carnitine available for use by the muscles can be manipulated both through exercise and dietary consumption.

Meat (especially red meat), fish, chicken, and dairy products are rich sources of L-carnitine, a non-essential amino acid that the body can synthesize from the essential amino acids lysine and methionine in limited amounts that are adequate for the maintenance of normal health. There is no recommended dietary allowance for L-carnitine, as nutritional L-carnitine deficiency has not been shown to occur in the absence of other mitigating factors.

L-carnitine, acetyl-L-carnitine, and propionyl-L-carnitine are available without a prescription as dietary supplements. There is no evidence that these three forms are significantly different, because the body’s systems efficiently remove the acetyl or propionyl groups, leaving just the L-carnitine. Carnitine is often promoted as an aid for weight loss, to improve exercise performance, and to enhance a sense of well-being, although it has also been purported to be useful for a range of chronic conditions.

Dose Range and Upper Limit

Food and Nutrition Board DRI:

\[ RDA/AI: \text{Not relevant for this substance.} \]

\[ \text{Upper Limit: Not relevant for this substance.} \]

Doses Used in Randomized Clinical Trials: Evidence from well-designed, randomized, controlled clinical studies indicate that supplements with up to 2,000 mg of L-carnitine per day are safe; higher doses have been studied, but insufficient data exist for safety.

Toxicology Data: At the time of this review, a toxic dose has not been established for L-carnitine. There are no reports of toxicity from an overdose of L-carnitine. Adverse effects during chronic use include nausea, vomiting, abdominal cramps, diarrhea, and drug-induced body odor. Intravenous doses of L-carnitine as high as 300 mg/kg have been administered with no apparent toxicity.
Evaluation of Potential Benefits

There is no consistent evidence that carnitine supplements can improve exercise or physical performance in healthy subjects. Feeding two to five grams per day of L-carnitine prior to a bout of exercise for one week to three months had no effect on perceived exertion, exercise performance, VO_{max} (a measure of aerobic fitness), or indicators of muscle metabolism. However, a small study of five athletes who took 15 g of carnitine one hour before exercise demonstrated significant improvement in exercise time to exhaustion on a cycle ergometer, and further improvement when carnitine was taken with caffeine (5 mg/kg body weight). There also appears to be no scientific evidence that L-carnitine supplements promote weight loss in humans.

Potential Detrimental Effects on...

Military Performance: While uncommon, doses of approximately two to six grams per day of L-carnitine supplements may cause nausea, vomiting, abdominal cramps, diarrhea, and a “fishy” body odor.

Military Survivability: DL-carnitine (a mixture of L and D forms), but not L-carnitine alone, has been associated with myasthenia syndrome (an autoimmune disorder) with severe weakness, muscle wasting, and discolored urine. Supplements with D-carnitine should be avoided.

Other Health Risks

Theoretically, L-carnitine might worsen symptoms of hypothyroidism (underactive thyroid) as it can inhibit entry of thyroid hormone into the nuclei of cells. Theoretically, taking L-carnitine might decrease the effectiveness of thyroid hormone replacement.

Interactions with Medications or Other Bioactive Substances

D-carnitine might compete with L-carnitine in the transport of usable carnitine within the body. Taking D-carnitine might cause symptoms (e.g., muscle weakness) of L-carnitine deficiency. Taking L-carnitine with thyroid hormone might decrease the effectiveness of the thyroid hormone. L-carnitine increases the anticoagulant effects of acenocoumarol and theoretically could have the same effect with warfarin.

For details of these and other potential interactions, visit the Natural Medicines Comprehensive Database.

Withdrawal Effects

Rebound deficiency (i.e., a shortage that can occur after consumption is discontinued) from prolonged use of L-carnitine continues to be a hypothetical concern, but the data available suggest that it does not occur.

Concern and Benefit Estimate (see Dietary Supplement Risk Matrix)

The rating here applies only to L-carnitine; supplements with D-carnitine should be avoided.

Benefit Potential: Low

Risk (safety concern): Low

Classification score: 6

There is no consistent evidence that carnitine supplements can alter fuel metabolism, improve exercise or physical performance, or promote weight loss in healthy subjects.

References