Carnitine Transports fatty acids into mitochondria; Decreases both mental and physical fatigue in clinical trials. 15,31,32

B Vitamins Necessary for converting food into energy; Cofactors in the mitochondrial

respiratory chain include B1, B2, B3, B5. B6. B12 and Folate.^{8,15,16,26-30}

Vitamin D Low levels are seen in patients with chronic fatigue syndrome; Deficiency causes reduced muscle strength.^{24,25}

Vitamin E Inverse correlation exists between fatigue and vitamin E levels.²³

Vitamin A When cellular levels of vitamin A are low, mitochondrial respiration and ATP production decreases.²²

Vitamin C Assists iron uptake and transport; Precursor to carnitine and several hormones that affect energy levels. Supplementation reduced fatigue in various trials. 15,16,21

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Chromium

Promotes glucose uptake into cells, helping stabilize blood sugar. 16,33

Deficiency lowers immunity and may cause muscle fatigue; Involved in several reactions for energy metabolism. 15,34,35

Asparagine Supplementation of this amino acid delayed fatigue during exercise by decreasing the rate at which glycogen was used up; needed for gluconeogenesis, a process that allows glucose to be made from protein to prevent blood sugar from getting too low.^{1,2,3}

Biotin Helps liver utilize glycogen for energy. Animal studies confirm that biotin deficiency causes clinical fatigue.⁴

Glutamine Mental and physical fatigue coincides with reduced levels of this amino acid in various tissues. Supplementation makes muscle more sensitive to insulin, increasing energy levels. 5.6.7

FATIGUE

Serine Counteracts the overproduction of fatigue-causing stress hormones.^{8,9}

causes fatigue due to its role in mitochondrial energy metabolism; therapeutic benefits particularly noticeable in chronic fatigue syndrome. 10,11,12,15

Antioxidants Several studies confirm that oxidative stress exacerbates clinical symptoms of fatigue. Mitochondrial dysfunction (inefficient energy metabolism) can be treated therapeutically with antioxidants such as Selenium, Cysteine, a-Lipoic acid and Glutathione, of which unusually low levels are seen in chronic fatigue patients. 12,16,18,19,20

Magnesium

Required to store energy molecule ATP; Repletion of magnesium in chronic fatigue patients shows clinical improvement in energy levels. 15,16,17

Fructose Intolerance Fatigue

(and hypoglycemia) are classic symptoms of this condition, since it depletes the main form of cellular energy, ATP.^{13,14}

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