

# Vitamins and Cancer Risk: A Comprehensive Review of Epidemiologic and Clinical Evidence

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**Introduction.** Vitamin supplementation nearly is universal among patients with cancer, yet the scientific landscape is far more complex. Across decades of research, vitamins have demonstrated profound biological effects ranging from immune activation and ferroptosis modulation to paradoxical tumor promotion. **Objective:** This scoping review maps the breadth of compelling and controversial evidence surrounding vitamins A, D, E, K, C, and the B-complex in cancer prevention, treatment response, and toxicity.

**Methods.** Guided by PRISMA-ScR domains, we synthesized mechanistic studies, epidemiologic cohorts, randomized trials, and therapeutic investigations addressing vitamins in the oncology context. Eligibility focused on sources examining cancer risk, progression, treatment interactions, or toxicity.

**Results.** Several vitamins exhibit striking anticancer mechanisms: vitamin K2 triggers autophagy-driven leukemia cell death; pharmacologic vitamin C selectively kills KRAS- and BRAF-mutated colorectal cancer cells; niacin reshapes the tumor immune microenvironment; and vitamin D enhances microbiome-dependent antitumor immunity. Yet the review also identifies potential harms, including beta-carotene increasing lung cancer risk in smokers, vitamin E raising prostate cancer risk, and antioxidant supplementation potentially weakening the oxidative mechanisms essential for chemotherapy and radiotherapy efficacy. Dose-response patterns frequently are U-shaped, with both deficiency and excess linked to greater risk. High-dose intravenous vitamin C, vitamin D repletion during immunotherapy, and vitamin-targeted nanoparticles emerge as promising but unproven therapeutic strategies.

**Conclusions.** Across vitamins, benefits appear highly context-dependent. Routine supplementation is unsupported, while targeted correction of true deficiencies remains essential. This rapidly evolving field demands individualized decision-making and rigorously designed trials to define when vitamins act as allies, and when they become adversaries, in cancer care.