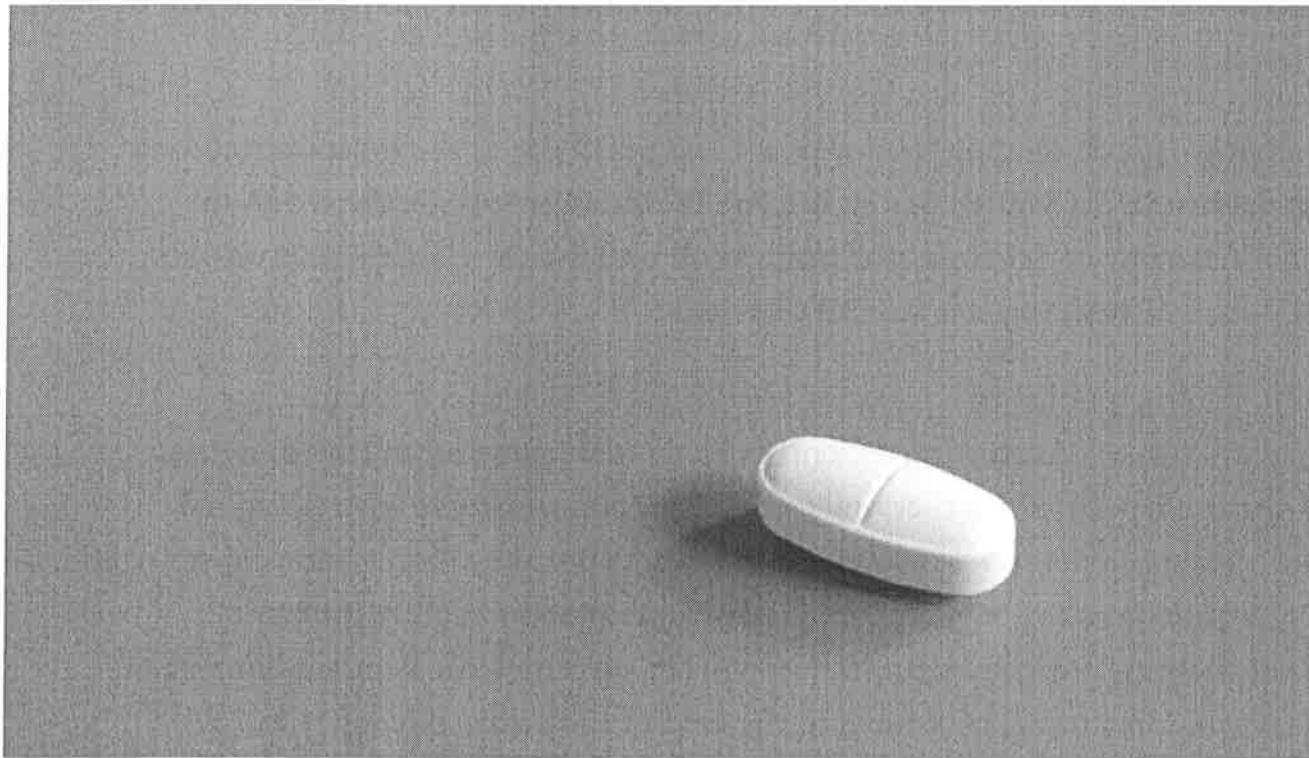


## HEALTH

# The Vitamin Myth: Why We Think We Need Supplements

Nutrition experts contend that all we need is what's typically found in a routine diet. Industry representatives, backed by a fascinating history, argue that foods don't contain enough, and we need supplements. Fortunately, many excellent studies have now resolved the issue.

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On October 10, 2011, researchers from the University of Minnesota found that women who took supplemental multivitamins died at rates higher than those who didn't. Two days later, researchers from the Cleveland Clinic found that men who took vitamin E had an increased risk of prostate cancer. "It's been a tough week for vitamins," said Carrie Gann of ABC News.

These findings weren't new. Seven previous studies had already shown that vitamins increased the risk of cancer and heart disease and shortened lives. Still, in 2012, more than half of all Americans took some form of vitamin supplements. What few

people realize, however, is that their fascination with vitamins can be traced back to one man. A man who was so spectacularly right that he won two Nobel Prizes and so spectacularly wrong that he was arguably the world's greatest quack.

In 1931, Linus Pauling published a paper in the *Journal of the American Chemical Society* titled "The Nature of the Chemical Bond." Before publication, chemists knew of two types of chemical bonds: ionic, where one atom gives up an electron to another; and covalent, where atoms share electrons. Pauling argued that it wasn't that simple -- electron sharing was somewhere between ionic and covalent.

Pauling's idea revolutionized the field, marrying quantum physics with chemistry. His concept was so revolutionary in fact that when the journal editor received the manuscript, he couldn't find anyone qualified to review it. When Albert Einstein was asked what he thought of Pauling's work, he shrugged his shoulders. "It was too complicated for me," he said.

For this single paper, Pauling received the Langmuir Prize as the most outstanding young chemist in the United States, became the youngest person elected to the National Academy of Sciences, was made a full professor at Caltech, and won the Nobel Prize in Chemistry. He was 30 years old.

In 1949, Pauling published a paper in *Science* titled "Sickle Cell Anemia, a Molecular Disease." At the time, scientists knew that hemoglobin (the protein in blood that transports oxygen) crystallized in the veins of people with sickle-cell anemia, causing joint pain, blood clots, and death. But they didn't know why. Pauling was the first to show that sickle hemoglobin had a slightly different electrical charge -- a quality that dramatically affected how the hemoglobin reacted with oxygen. His finding gave birth to the field of molecular biology.

In 1951, Pauling published a paper in the *Proceedings of the National Academy of Sciences* titled "The Structure of Proteins." Scientists knew that proteins were composed of a series of amino acids. Pauling proposed that proteins also had a secondary structure determined by how they folded upon themselves. He called one configuration the alpha helix -- later used by James Watson and Francis Crick to explain the structure of DNA.

In 1961, Pauling collected blood from gorillas, chimpanzees, and monkeys at the San Diego Zoo. He wanted to see whether mutations in hemoglobin could be used as a kind of evolutionary clock. Pauling showed that humans had diverged from

gorillas about 11 million years ago, much earlier than scientists had suspected. A colleague later remarked, "At one stroke he united the fields of paleontology, evolutionary biology, and molecular biology."

Pauling's accomplishments weren't limited to science. Beginning in the 1950s -- and for the next forty years -- he was the world's most recognized peace activist. Pauling opposed the internment of Japanese Americans during World War II, declined Robert Oppenheimer's offer to work on the Manhattan Project, stood up to Senator Joseph McCarthy by refusing a loyalty oath, opposed nuclear proliferation, publicly debated nuclear-arms hawks like Edward Teller, forced the government to admit that nuclear explosions could damage human genes, convinced other Nobel Prize winners to oppose the Vietnam War, and wrote the best-selling book *No More War!* Pauling's efforts led to the Nuclear Test Ban Treaty. In 1962, he won the Nobel Peace Prize -- the first person ever to win two unshared Nobel Prizes.

In addition to his election to the National Academy of Sciences, two Nobel Prizes, the National Medal of Science, and the Medal for Merit (which was awarded by the president of the United States), Pauling received honorary degrees from Cambridge University, the University of London, and the University of Paris. In 1961, he appeared on the cover of *Time* magazine's Men of the Year issue, hailed as one of the greatest scientists who had ever lived.

Then all the rigor, hard work, and hard thinking that had made Linus Pauling a legend disappeared. In the words of a colleague, his "fall was as great as any classic tragedy."

The turning point came in March 1966, when Pauling was 65 years old. He had just received the Carl Neuberg Medal. "During a talk in New York City," recalled Pauling, "I mentioned how much pleasure I took in reading about the discoveries made by scientists in their various investigations of the nature of the world, and stated that I hoped I could live another twenty-five years in order to continue to have this pleasure. On my return to California I received a letter from a biochemist, Irwin Stone, who had been at the talk. He wrote that if I followed his recommendation of taking 3,000 milligrams of vitamin C, I would live not only 25 years longer, but probably more." Stone, who referred to himself as Dr. Stone, had spent two years studying chemistry in college. Later, he received an honorary degree

from the Los Angeles College of Chiropractic and a "PhD" from Donsbach University, a non-accredited correspondence school in Southern California.

Pauling followed Stone's advice. "I began to feel livelier and healthier," he said. "In particular, the severe colds I had suffered several times a year all my life no longer occurred. After a few years, I increased my intake of vitamin C to ten times, then twenty times, and then three hundred times the RDA: now 18,000 milligrams per day."

From that day forward, people would remember Linus Pauling for one thing: vitamin C.

In 1970, Pauling published *Vitamin C and the Common Cold*, urging the public to take 3,000 milligrams of vitamin C every day (about 50 times the recommended daily allowance). Pauling believed that the common cold would soon be a historical footnote. "It will take decades to eradicate the common cold completely," he wrote, "but it can, I believe, be controlled entirely in the United States and some other countries within a few years. I look forward to witnessing this step toward a better world." Pauling's book became an instant best seller. Paperback versions were printed in 1971 and 1973, and an expanded edition titled *Vitamin C, the Common Cold and the Flu*, published three years later, promised to ward off a predicted swine flu pandemic. Sales of vitamin C doubled, tripled, and quadrupled. Drugstores couldn't keep up with demand. By the mid-1970s, 50 million Americans were following Pauling's advice. Vitamin manufacturers called it "the Linus Pauling effect."

Scientists weren't as enthusiastic. On December 14, 1942, about thirty years before Pauling published his first book, Donald Cowan, Harold Diehl, and Abe Baker, from the University of Minnesota, published a paper in the *Journal of the American Medical Association* titled "Vitamins for the Prevention of Colds." The authors concluded, "Under the conditions of this controlled study, in which 980 colds were treated . . . there is no indication that vitamin C alone, an antihistamine alone, or vitamin C plus an antihistamine have any important effect on the duration or severity of infections of the upper respiratory tract."

Other studies followed. After Pauling's pronouncement, researchers at the University of Maryland gave 3,000 milligrams of vitamin C every day for three weeks to eleven volunteers and a sugar pill (placebo) to ten others. Then they

infected volunteers with a common cold virus. All developed cold symptoms of similar duration. At the University of Toronto, researchers administered vitamin C or placebo to 3,500 volunteers. Again, vitamin C didn't prevent colds, even in those receiving as much as 2,000 milligrams a day. In 2002, researchers in the Netherlands administered multivitamins or placebo to more than 600 volunteers. Again, no difference. At least 15 studies have now shown that vitamin C doesn't treat the common cold. As a consequence, neither the FDA, the American Academy of Pediatrics, the American Medical Association, the American Dietetic Association, the Center for Human Nutrition at the Johns Hopkins Bloomberg School of Public Health, nor the Department of Health and Human Services recommend supplemental vitamin C for the prevention or treatment of colds.

Although study after study showed that he was wrong, Pauling refused to believe it, continuing to promote vitamin C in speeches, popular articles, and books. When he occasionally appeared before the media with obvious cold symptoms, he said he was suffering from allergies.

Then Linus Pauling upped the ante. He claimed that vitamin C not only prevented colds; it cured cancer.

In 1971, Pauling received a letter from Ewan Cameron, a Scottish surgeon from a tiny hospital outside Glasgow. Cameron wrote that cancer patients who were treated with ten grams of vitamin C every day had fared better than those who weren't. Pauling was ecstatic. He decided to publish Cameron's findings in the *Proceedings of the National Academy of Sciences (PNAS)*. Pauling assumed that as a member of the academy he could publish a paper in *PNAS* whenever he wanted; only three papers submitted by academy members had been rejected in more than half a century. Pauling's paper was rejected anyway, further tarnishing his reputation among scientists. Later, the paper was published in *Oncology*, a journal for cancer specialists. When researchers evaluated the data, the flaw became obvious: the cancer victims Cameron had treated with vitamin C were healthier at the start of therapy, so their outcomes were better. After that, scientists no longer took Pauling's claims about vitamins seriously.

But Linus Pauling still had clout with the media. In 1971, he declared that vitamin C would cause a 10 percent decrease in deaths from cancer. In 1977, he went even further. "My present estimate is that a decrease of 75 percent can be achieved with

vitamin C alone," he wrote, "and a further decrease by use of other nutritional supplements." With cancer in their rearview mirror, Pauling predicted, Americans would live longer, healthier lives. "Life expectancy will be 100 to 110 years," he said, "and in the course of time, the maximum age might be 150 years."

Cancer victims now had reason for hope. Wanting to participate in the Pauling miracle, they urged their doctors to give them massive doses of vitamin C. "For about seven or eight years, we were getting a lot of requests from our families to use high-dose vitamin C," recalls John Maris, chief of oncology and director of the Center for Childhood Cancer Research at the Children's Hospital of Philadelphia. "We struggled with that. They would say, 'Doctor, do you have a Nobel Prize?'"

Blindsided, cancer researchers decided to test Pauling's theory. Charles Moertel, of the Mayo Clinic, evaluated 150 cancer victims: half received ten grams of vitamin C a day and half didn't. The vitamin C-treated group showed no difference in symptoms or mortality. Moertel concluded, "We were unable to show a therapeutic benefit of high-dose vitamin C." Pauling was outraged. He wrote an angry letter to the *New England Journal of Medicine*, which had published the study, claiming that Moertel had missed the point. Of course vitamin C hadn't worked: Moertel had treated patients who had already received chemotherapy. Pauling claimed that vitamin C worked only if cancer victims had received no prior chemotherapy.

Bullied, Moertel performed a second study; the results were the same. Moertel concluded, "Among patients with measurable disease, none had objective improvement. It can be concluded that high-dose vitamin C therapy is not effective against advanced malignant disease regardless of whether the patient had received any prior chemotherapy." For most doctors, this was the end of it. But not for Linus Pauling. He was simply not to be contradicted. Cameron observed, "I have never seen him so upset. He regards the whole affair as a personal attack on his integrity." Pauling thought Moertel's study was a case of "fraud and deliberate misrepresentation." He consulted lawyers about suing Moertel, but they talked him out of it.

Subsequent studies have consistently shown that vitamin C doesn't treat cancer.

Pauling wasn't finished. Next, he claimed that vitamin C, when taken with massive doses of vitamin A (25,000 international units) and vitamin E (400 to 1,600 IU), as well as selenium (a basic element) and beta-carotene (a precursor to vitamin A),

could do more than just prevent colds and treat cancer; they could treat virtually every disease known to man. Pauling claimed that vitamins and supplements could cure heart disease, mental illness, pneumonia, hepatitis, polio, tuberculosis, measles, mumps, chickenpox, meningitis, shingles, fever blisters, cold sores, canker sores, warts, aging, allergies, asthma, arthritis, diabetes, retinal detachment, strokes, ulcers, shock, typhoid fever, tetanus, dysentery, whooping cough, leprosy, hay fever, burns, fractures, wounds, heat prostration, altitude sickness, radiation poisoning, glaucoma, kidney failure, influenza, bladder ailments, stress, rabies, and snakebites. When the AIDS virus entered the United States in the 1970s, Pauling claimed vitamins could treat that, too.

On April 6, 1992, the cover of *Time* -- rimmed with colorful pills and capsule -- declared: "The Real Power of Vitamins: New research shows they may help fight cancer, heart disease, and the ravages of aging." The article, written by Anastasia Toufexis, echoed Pauling's ill-founded, disproved notions about the wonders of megavitamins. "More and more scientists are starting to suspect that traditional medical views of vitamins and minerals have been too limited," wrote Toufexis. "Vitamins -- often in doses much higher than those usually recommended -- may protect against a host of ills ranging from birth defects and cataracts to heart disease and cancer. Even more provocative are glimmerings that vitamins can stave off the normal ravages of aging." Toufexis enthused that the "pharmaceutical giant Hoffman-La Roche is so enamored with beta-carotene that it plans to open a Freeport, Texas, plant next year that will churn out 350 tons of the nutrient annually, or enough to supply a daily 6 milligram capsule to virtually every American adult."

The National Nutritional Foods Association (NNFA), a lobbying group for vitamin manufacturers, couldn't believe its good luck, calling the *Time* article "a watershed event for the industry." As part of an effort to get the FDA off their backs, the NNFA distributed multiple copies of the magazine to every member of Congress. Speaking at an NNFA trade show later in 1992, Toufexis said, "In fifteen years at *Time* I have written many health covers. But I have never seen anything like the response to the vitamin cover. It whipped off the sales racks, and we were inundated with requests for copies. There are no more copies. 'Vitamins' is the number-one-selling issue so far this year."

Although studies had failed to support him, Pauling believed that vitamins and supplements had one property that made them cure-alls, a property that continues to be hawked on everything from ketchup to pomegranate juice and that rivals words like *natural* and *organic* for sales impact: *antioxidant*.

Antioxidation vs. oxidation has been billed as a contest between good and evil. The battle takes place in cellular organelles called mitochondria, where the body converts food to energy, a process that requires oxygen and so is called oxidation. One consequence of oxidation is the generation of electron scavengers called free radicals (evil). Free radicals can damage DNA, cell membranes, and the lining of arteries; not surprisingly, they've been linked to aging, cancer, and heart disease. To neutralize free radicals, the body makes its own antioxidants (good). Antioxidants can also be found in fruits and vegetables -- specifically, selenium, beta-carotene, and vitamins A, C, and E. Studies have shown that people who eat more fruits and vegetables have a lower incidence of cancer and heart disease and live longer. The logic is obvious: if fruits and vegetables contain antioxidants -- and people who eat lots of fruits and vegetables are healthier -- then people who take supplemental antioxidants should also be healthier.

In fact, they're less healthy.

In 1994, the National Cancer Institute, in collaboration with Finland's National Public Health Institute, studied 29,000 Finnish men, all long-term smokers more than fifty years old. This group was chosen because they were at high risk for cancer and heart disease. Subjects were given vitamin E, beta-carotene, both, or neither. The results were clear: those taking vitamins and supplements were *more* likely to die from lung cancer or heart disease than those who didn't take them -- the opposite of what researchers had anticipated.

In 1996, investigators from the Fred Hutchinson Cancer Research Center, in Seattle, studied 18,000 people who, because they had been exposed to asbestos, were at increased risk of lung cancer. Again, subjects received vitamin A, beta-carotene, both, or neither. Investigators ended the study abruptly when they realized that those who took vitamins and supplements were dying from cancer and heart disease at rates 28 and 17 percent higher, respectively, than those who didn't.

In 2004, researchers from the University of Copenhagen reviewed fourteen randomized trials involving more than 170,000 people who took vitamins A, C, E,

and beta-carotene to see whether antioxidants could prevent intestinal cancers. Again, antioxidants didn't live up to the hype. The authors concluded, "We could not find evidence that antioxidant supplements can prevent gastrointestinal cancers; on the contrary, *they seem to increase overall mortality.*" When these same researchers evaluated the seven best studies, they found that death rates were 6 percent higher in those taking vitamins.

In 2005, researchers from Johns Hopkins School of Medicine evaluated nineteen studies involving more than 136,000 people and found an increased risk of death associated with supplemental vitamin E. Dr. Benjamin Caballero, director of the Center for Human Nutrition at the Johns Hopkins Bloomberg School of Public Health, said, "This reaffirms what others have said. The evidence for supplementing with any vitamin, particularly vitamin E, is just not there. This idea that people have that [vitamins] will not hurt them may not be that simple." That same year, a study published in the *Journal of the American Medical Association* evaluated more than 9,000 people who took high-dose vitamin E to prevent cancer; those who took vitamin E were *more* likely to develop heart failure than those who didn't.

In 2007, researchers from the National Cancer Institute examined 11,000 men who did or didn't take multivitamins. Those who took multivitamins were twice as likely to die from advanced prostate cancer.

In 2008, a review of all existing studies involving more than 230,000 people who did or did not receive supplemental antioxidants found that vitamins increased the risk of cancer and heart disease.

On October 10, 2011, researchers from the University of Minnesota evaluated 39,000 older women and found that those who took supplemental multivitamins, magnesium, zinc, copper, and iron died at rates higher than those who didn't. They concluded, "Based on existing evidence, we see little justification for the general and widespread use of dietary supplements."

Two days later, on October 12, researchers from the Cleveland Clinic published the results of a study of 36,000 men who took vitamin E, selenium, both, or neither. They found that those receiving vitamin E had a 17 percent greater risk of prostate cancer. In response to the study, Steven Nissen, chairman of cardiology at the Cleveland Clinic, said, "The concept of multivitamins was sold to Americans by an eager nutraceutical industry to generate profits. There was never any scientific data

supporting their usage." On October 25, a headline in the *Wall Street Journal* asked, "Is This the End of Popping Vitamins?" Studies haven't hurt sales. In 2010, the vitamin industry grossed \$28 billion, up 4.4 percent from the year before. "The thing to do with [these reports] is just ride them out," said Joseph Fortunato, chief executive of General Nutrition Centers. "We see no impact on our business."

How could this be? Given that free radicals clearly damage cells -- and given that people who eat diets rich in substances that neutralize free radicals are healthier -- why did studies of supplemental antioxidants show they were harmful? The most likely explanation is that free radicals aren't as evil as advertised. Although it's clear that free radicals can damage DNA and disrupt cell membranes, that's not always a bad thing. People need free radicals to kill bacteria and eliminate new cancer cells. But when people take large doses of antioxidants, the balance between free radical production and destruction might tip too much in one direction, causing an unnatural state in which the immune system is less able to kill harmful invaders. Researchers have called this "the antioxidant paradox." Whatever the reason, the data are clear: high doses of vitamins and supplements increase the risk of heart disease and cancer; for this reason, not a single national or international organization responsible for the public's health recommends them.

In May 1980, during an interview at Oregon State University, Linus Pauling was asked, "Does vitamin C have any side effects on long-term use of, let's say, gram quantities?" Pauling's answer was quick and decisive. "No," he replied.

Seven months later, his wife was dead of stomach cancer. In 1994, Linus Pauling died of prostate cancer.

*This is an excerpt from Do You Believe in Magic? The Sense and Nonsense of Alternative Medicine.*

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