[REALITY IS THE BEST MEDICINE HARRIET HALL

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Misconceptions about Vitamins

In 1747, one of the first controlled clinical trials in the history of medical science involved vitamin C, though the researcher had no idea what a vitamin was; the vitamin wasn't discovered until 1912. Scurvy, a disease caused by vitamin C deficiency, was rampant in the British Royal Navy, disabling and killing more sailors than combat, storms, shipwreck, and all other causes combined. James Lind compared these six proposed remedies:

- a quart of cider a day;
- 25 drops of elixir of vitriol three times a day;
- half a pint of seawater a day;
- a nutmeg-sized paste of garlic, mustard seed, horseradish, balsam of Peru, and gum myrrh three times a day;
- two spoonfuls of vinegar three times a day;
- two oranges and one lemon a day.

The first five proved useless; the last one worked like a charm. Lind's experiment established that scurvy could be cured (and it can also be prevented) by adding fresh citrus fruits to the diet. This eventually led to the nickname "Limeys" for British sailors. It took a long time for the Royal Navy to adopt fresh citrus fruits. One glitch was that they assumed bottled lemon juice would do the trick; they didn't know that the heat used in the bottling process destroyed the vitamin C.

Alas, poor Lind! He didn't understand the significance of his experiment. He continued to believe scurvy was a digestive disease caused by blocked sweat glands.

Fast forward to the present: Vitamins are assumed to be some kind of miraculous panacea. People think they make us healthier, make us live longer, give us more energy, and prevent and reverse disease. Until 1935, food was the only source of vitamins, but today we can get them from pills, dietary supplements, and fortified foods.

How many people take vitamins? A

2019 Harris poll found that 86 percent of American adults take vitamins or supplements (American Osteopathic Association 2019); other estimates are lower but usually over half. Vitamins are commonly added to other supplements and untested alternative health mixtures, adding a veneer of health to unhealthy products. Many people take vitamins, but most of them are taking them for the wrong reasons and due to misunderstandings.

The book *Vitamania: Our Obsessive Quest for Nutritional Perfection* by Catherine Price explains our obsession with vitamins, which she argues are actually making us less healthy. She says, "We are such believers in vitamins' goodness that we don't realize just how much scientists still don't understand about how vitamins work in our bodies, or how much of each we require."

Vitamins Defined

Vitamins are essential nutrients that we must eat because our bodies can't make them. There are other such essential nutrients, such as minerals and some fatty acids, but they are not classified as vitamins. Macronutrients (carbohydrates, fats, and protein) are burned as fuel; vitamins are not. Their role is to facilitate the chemical reactions that keep us alive. Tiny amounts are enough: the recommended amount of vitamin B12 is equivalent to one sixty-seventh the weight of one grain of salt.

There are thirteen vitamins. Four are fat-soluble (A, D, E, and K). Fat is required for their absorption, and they are stored in body fat, where they can accumulate to high levels over time. The other nine are water-soluble: vitamin C and the eight B-complex vitamins. Thiamine is B1, riboflavin is B2, niacin is B3, pantothenic acid is B5, pyridoxine is B6, biotin is B7, folate/folic acid is B9, and cobalamin is B12. (The missing B numbers were for substances that were once thought to be vitamins but turned out not to be.) Water-soluble vitamins are not stored and must be regularly replenished.

Sometimes vitamins are indicated for healthy people: vitamin K at birth, folic acid to prevent neural tube defects in fetuses, and prenatal vitamins. Breast milk is said to be the perfect food for babies, but healthy breast-fed babies require vitamin K at birth and ongoing supplementation with iron, vitamin D, and fluoride. Otherwise, vitamins are not indicated unless you have a vitamin deficiency. If you don't have a documented vitamin deficiency, taking vitamins will do nothing but give you expensive pee. We don't know whether moderate deficiencies have any effect on health. In fact, trying to determine whether an individual has a significant vitamin deficiency is largely a guessing game.

Vitamins come in many different chemical forms. Vitamin B9 occurs as folic acid, dihydrofolate (DHF), tetrahydrofolate (THF), 5, 10-methylenetetrahydrofolate (5, 10-MTHF), and 5-methyltetrahydrofolate (5-MTHF). Try saying that fast ten times in a row! Folic acid is better absorbed than folate. Folate from natural sources is unlikely to cause side effects. Folic acid is synthetic; side effects are uncommon but can include bloating, appetite loss, and nausea.

Vitamin Risks

Many people think vitamins are risk free and assume that if some is good, more will be better. This misconception led to megavitamin therapy and orthomolecular medicine, neither of which is supported by science.

Some people claim that our foods are no longer nutritious due to soil depletion; that's not true (Langer 2020). Some people assume that the more vitamins a food contains, the better it is for you. That isn't necessarily true either: if you add a lot of vitamins to a food that contains water or sugar but no other nutrients (in other words, "empty calories"), it doesn't mean it is a good choice for you.

Linus Pauling was smart enough to win two Nobel Prizes, but he wasn't smart enough to realize he was wrong about vitamin C. He thought it prevented and cured the common cold, but a systematic review has found otherwise

(Hemilä and Chalker 2013). Pauling upped his intake to eighteen grams a day, but that's nine times the tolerable upper limit of two grams a day. Commonly recommended doses of vitamin C are known to cause nausea and diarrhea.

Humans and a few other simians, fruit bats, and guinea pigs are the only mammals that can't make their own vitamin C. Genetic analysis shows that we once had that ability; evolutionary biologists have speculated that losing it probably gave us some kind of evolutionary advantage (Hornung and Biesalski 2019). Various hypotheses have been suggested. I wonder if new technologies of genetic engineering might someday restore our ability to make our own vitamin C.

In the 1990s, cardiologists were recommending vitamin E and folic acid to all their patients, because preliminary research suggested these vitamins would reduce the risk of heart disease. They stopped recommending them when better studies showed those vitamins not only failed to protect the heart, but high-dose vitamin E was linked to a higher risk of heart failure, prostate cancer, and death (Szabo 2018). Oops!

Several Arctic explorers were thought

to have died from vitamin A poisoning after eating polar bear liver, which has the highest level of vitamin A of any animal. That may be a myth; their cause of death has been questioned. However, vitamin A is definitely known to be toxic in large doses.

Health food websites and marketers claim that most of the U.S. population has vitamin deficiency. The website for a company called Biostation claims that number is as high as 92 percent. I can't believe that, because vitamin deficiency diseases have become rare in the developed world. Other questionable sources say everyone should take a multivitamin. I don't agree. I don't think we even know how to diagnose significant deficiencies in individuals.

Deficiency Defined

We read the numbers on food labels and trust them because they are precise numbers that look very scientific. But they don't mean what we think they mean. Recommended Dietary Allowances (RDAs) are not meant to be applied to individuals. They are the amounts estimated to meet the needs of 97–98 percent of the population; many individuals might get by with much less. RDAs have never been established for biotin, pantothenic acid, or vitamin K, and there are no RDAs for infants under the age of one year for *any* vitamin. I bet you didn't know that; I didn't. *Dietary Reference Intake* (DRI) is the general term for a set of reference values used to plan and assess nutrient intakes of healthy people. These values vary by age and sex, activity levels, and other factors.

Estimated Average Requirements (EARs) are lower than RDAs. They are meant to meet the needs of 50 percent of people in an age group. The EAR is the amount of a nutrient that is estimated to meet the requirement for a specific criterion of adequacy of half of the healthy individuals of a specific age, sex, and life stage. As with RDAs, EARs were never meant to be used by individuals to measure the adequacy of their nutrition.

Vitamin levels are fiendishly difficult to measure accurately. They vary from day to day as well as by where they are measured in the body.

We must face reality: the diagnosis of a nutrient deficiency is a very uncertain business. We don't really know how much of each nutrient we need to survive. We have no idea what the optimum amounts are for ideal health. And we certainly don't know the health consequences of a mild deficiency; maybe most of us can tolerate a mild deficiency with no ill effects. If you read a recommendation that "everyone should take this," you will know to disregard it, because the evidence is not clear and we are not all the same.

Who Needs Multivitamins?

The health of people who take a daily multivitamin is not appreciably different from the health of those who don't. Some studies have shown a mild decrease in the risk of cancer; others have not. Some studies have shown that people who take multivitamins don't live as long, but those studies may be flawed.

According to a Harvard website:

> After a review of 26 clinical and cohort studies, the U.S. Preventive Services Task Force concluded there was insufficient evidence to support any benefits of multivitamins or individual vitamins for the primary prevention of cardiovascular disease or cancer among healthy, nutrient-sufficient adults. … A diet that includes plenty of fruits, vegetables, whole grains, good protein sources, and healthful fats should provide most of the nutrients needed for good health. (Harvard T.H. Chan School of Public Health. N.d.)

Taking a daily multivitamin is probably safe and has been recommended as a form of "insurance." I used to think of it as psychotherapy. I worried about whether I was eating right, and a multivitamin gave me an excuse to stop worrying. I soon realized that a faulty diet would be better addressed by improving the diet rather than taking a pill. Food has a vast array of nutrients and supplies fiber and enjoyment not to be found in a pill. Beware of charlatans who offer to give you personalized nutrition advice based on your genome. They can't do that.

In the face of all this uncertainty, what are we to do? I think it's a mistake to succumb to vitamania. Rather than obsessing over our nutrition, we can focus on remembering that food is one of the great pleasures of life, and shared meals facilitate social interactions. I am reassured by two things: 1) vitamin deficiency diseases are very rare in America, occurring only in individuals whose diet is limited, faddish, bizarre, or atypical in some way; and 2) the tiny amounts of vitamins we need can be found in a variety of different foods.

As the author of *Vitamania* said, "The healthiest, most scientific, and most pleasurable way to eat is not that complicated at all." Just eat a wide variety of foods that you enjoy, mostly plants, including plenty of fruits and vegetables, and don't eat too much (avoid becoming overweight). ■

References

American Osteopathic Association. 2019. Poll finds 86% of Americans take vitamins or supplements yet only 21% have a confirmed nutritional deficiency. Available online at https://www.prnewswire.com/news-releases/poll-finds-86-of-americans-take-vitamins-or-supplements-yet-only-21-have-a-confirmed-nutritional-deficiency-300779470.html.

Harvard T.H. Chan School of Public Health. N.d. Should I take a daily multivitamin? Available online at https://www.hsph.harvard.edu/nutritionsource/multivitamin/.

Hemilä, Harri, and Elizabeth Chalker. 2013. Vitamin C for preventing and treating the common cold. *The Cochrane Database of Systematic Reviews* (January 31). Available online at https://pubmed.ncbi.nlm.nih.gov/23440782/.

Hornung, Tabea C., and Hans-Konrad Biesalski. 2019. Glut-1 explains the evolutionary advantage of the loss of endogenous vitamin C-synthesis: The electron transfer hypothesis. *Evolution, Medicine, and Public Health* 1: 221–231. Available online at https://academic.oup.com/emph/article/2019/1/221/5556105.

Langer, Abby. 2020. Is soil depletion causing our food to be less nutritious than it used to be? *Abby Langer Nutrition* (May 29). Available online at https://abbylangernutrition.com/is-soil-depletion-causing-our-food-to-be-less-nutritious-than-it-used-to-be/.

Szabo, Liz. 2018. Older Americans are 'hooked' on vitamins. *New York Times* (April 3). Available online at https://www.nytimes.com/2018/04/03/well/older-americans-vitamins-dietary-supplements.html.