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Ominous B1 Deficiency Found Throughout Food Chain

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STORY AT-A-GLANCE -

- Vitamin B1 (thiamine) is used by nearly all your cells, metabolizing the carbohydrates and lipids in the foods you eat, helping to convert food into energy and boosting the flow of electrolytes in and out of your nerves and muscles
- Thiamine is important for healthy immune function, and may actually be crucial to protect against infectious respiratory illnesses such as COVID-19
- While thiamine deficiency is often the result of alcohol misuse, chronic infections, poor nutrition and/or malabsorption, recent research suggests vitamin B1 has dramatically declined throughout the food chain in recent years
- The transfer of thiamine up the food chain may be blocked by a number of factors, including the overabundance of thiaminase, an enzyme that destroys thiamine. Thiaminase is naturally present in certain microorganisms, plants and fish that have adapted to use it to their advantage
- Thiamine deficiency has been identified in dozens of animal species and is now suspected of driving declines in wildlife populations across the northern hemisphere. This means our diets are likely to be low in thiamine, thereby raising the risk for thiamine deficiency in the human population

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Vitamin B1 (thiamine) is used by nearly all your cells, and helps to metabolize the carbohydrates and lipids in the foods you eat. It also facilitates converting your food into energy and boosting the flow of electrolytes in and out of your nerves and muscles. It's considered "essential" because your body can't produce it on its own; it must come from an outside source.

Thiamine is sometimes referred to as an "antistress" vitamin for its positive influence on your central nervous system, and it's also important for healthy immune function. In addition to nutrients such as zinc and vitamins C and D, vitamin B1 (thiamine) may actually be crucial to protect against infectious respiratory illnesses such as COVID-19.

Thiamine deficiency syndrome (beriberi) has also been implicated in other types of severe infections and bears many similarities to sepsis. This is one of the reasons why thiamine is such an important part of Dr. Paul Marik's sepsis treatment.[1] Sepsis, in turn, is a major contributor in influenza deaths in general, and a primary cause for COVID-19 deaths specifically.

While thiamine deficiency is often the result of alcohol misuse, chronic infections, poor nutrition and/or malabsorption, recent research suggests vitamin B1 availability has dramatically declined throughout the food chain in recent years.[2]

Lack of Thiamine Is Disrupting Ecosystem

In a January 28, 2021, article in Hakai Magazine,[3] Alastair Bland reviews findings showing certain marine ecosystems are being decimated by an apparent lack of thiamine. Problems were noticed in January 2020 at salmon hatcheries in California. Fish were acting disoriented and mortality was surprisingly high.

Initially, they feared a virus might be at play, but after digging through the medical literature, they found research discussing thiamine deficiency in marine life. As noted in the article, vitamin B1 is "a basic building block of life critical to the functioning of cells and in converting food into energy."

Biologists tested the theory by dissolving thiamine powder into the water, and within hours, nearly all of the fish were acting normally again. Meanwhile, the behavior of fish in an untreated batch continued to decline. As a result of this research, many hatcheries took to applying thiamine, but the underlying problem still remains.

> *"Since the fish acquire thiamine by ingesting it through their food, and females pass nutrients to their eggs, the troubling condition indicated that something was amiss in the Pacific Ocean, the last place the fish eat before entering fresh water to spawn,"* Bland writes, adding:
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> *"California researchers now investigating the source of the salmon's nutritional problems find themselves contributing to an international effort to understand thiamine deficiency, a disorder that seems to be on the rise in marine ecosystems across much of the planet.*
>
> *It's causing illness and death in birds, fish, invertebrates, and possibly mammals, leading scientists from Seattle to Scandinavia to suspect some unexplained process is compromising the foundation of the Earth's food web by depleting ecosystems of this critical nutrient."*

What's Causing Ecosystem-Wide Thiamine Deficiency?

As explained by Bland, "Thiamine originates in the lowest levels of the food web." Certain species of bacteria, phytoplankton, fungi and even some plants are responsible for synthesizing thiamine from other precursor compounds.

From there, thiamine makes its way through both the animal and plant kingdoms. All organisms need it. In animals, enzymes interact with thiamine to generate cellular energy. Without sufficient amounts of thiamine, fundamental metabolic processes start to fail, causing neurological disturbances, reproductive problems and increased mortality.

While beriberi has been recognized as a serious health risk in humans for nearly 100 years, and thiamine supplementation has been standard practice for domesticated

livestock such as sheep, cattle, mink and goats for several decades,[4] the presence in and effect of thiamine deficiency on wildlife wasn't discovered until the 1990s, when Canadian scientist John Fitzsimons started investigating the decline in Great Lakes trout. Bland writes:[5]

> *"Studying lake trout born in captivity, Fitzsimons observed symptoms like hyperexcitability, loss of equilibrium, and other abnormal behavior.*
>
> *He wondered if a nutritional deficiency was at play, and to test for this he dissolved various vitamin tablets in water and — using trout in different life stages, including fertilized eggs — administered the solutions to the fish, both through injection and baths.*
>
> *The idea was to see which vitamin, if any, cured the condition. 'It came down to a range of B vitamins, and it was only the thiamine that was able to reverse the signs I was seeing,' he says."*

Since the publication of Fitzsimons' findings in 1995, thiamine deficiency has been identified in dozens of animal species, including birds and moose. While severe deficiency has lethal consequences, sublethal deficiency can have insidiously devastating effects, including:[6]

- Lowering strength and coordination
- Reducing fertility
- Impairing memory and causing other neurobehavioral deficits.[7] In humans, thiamine deficiency has been shown to play a role in cases of delirium. In one study,[8] 45% of cancer patients suffering from delirium had thiamine deficiency, and 60% recovered when treated with intravenous thiamine
- Paralysis
- Loss of vocalization

B1 Deficiency May Be Responsible for Wildlife Declines

Thiamine deficiency is now suspected of driving declines in wildlife populations all across the northern hemisphere.[9] Bland cites research showing marine and terrestrial wildlife populations declined by half between 1970 and 2012. Between 1950 and 2010, the global seabird population declined by 70%.[10]

> **“The transfer of thiamine up the food chain may be blocked by a number of factors, including overfishing. But there's yet another possibility, and that is the overabundance of thiaminase, an enzyme that destroys thiamine. Thiaminase is naturally present in certain microorganisms, plants and fish that have adapted to use it to their advantage.”**

While habitat loss and other environmental factors are known to impact biodiversity, these declines are allegedly occurring far faster than can be explained by such factors. Researchers strongly suspect human involvement, but how?

> *"Scientists are floating various explanations for what's depriving organisms of this nutrient, and some believe that changing environmental conditions, especially in the ocean, may be stifling thiamine production or its transfer between producers and the animals that eat them,"* Bland writes.[11]
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> *"Sergio Sañudo-Wilhelmy, a University of Southern California biogeochemist, says warming ocean water could be affecting the populations of microorganisms that produce thiamine and other vitamins, potentially upsetting basic chemical balances that marine ecosystems depend on.*
>
> *'In different temperatures, different phytoplankton and bacteria grow faster,' he says. This, he explains, could hypothetically allow microorganisms that do not produce thiamine — but, instead, acquire it through their diet — to outcompete the thiamine producers, effectively reducing thiamine concentrations in the food web."*

The transfer of thiamine up the food chain may be blocked by a number of factors, including overfishing. But there's yet another possibility, and that is the overabundance of thiaminase, an enzyme that destroys thiamine. Thiaminase is naturally present in certain microorganisms, plants and fish that have adapted to use it to their advantage.

"When larger animals eat prey containing thiaminase, the enzyme rapidly destroys thiamine and can lead to a nutritional deficiency in the predator," Bland explains. One thiaminase-rich species is an invasive species of herring called alewife, which during the 20th century have spread through the Great Lakes, displacing native species.

This, some researchers believe, has led to chronic and severe thiamine deficiency in larger fish species. "The Great Lakes' saga illustrates the outsized impact that one single nutrient can have on an entire ecosystem," Bland writes.

An overabundance of thiaminase-containing species also appears to be responsible for the decline in Sacramento River salmon. In this case, northern anchovy, which is rich in thiaminase, is the suspected culprit.

Unfortunately, few answers have emerged as of yet. Giving thiamine to fish in hatcheries is not a long-lasting solution, because once they re-enter the wild, the deficiency reemerges. One scientist likened the practice to "sending a kid with a fever off to school after giving them a Tylenol."[12]

Signs and Symptoms of Thiamine Deficiency

Considering both plants and wildlife are becoming increasingly thiamine-deficient, it's logical to suspect that this deficiency is becoming more common in the human population as well. Early symptoms of thiamine deficiency include:[13,14]

- Fatigue and muscle weakness
- Confusion and/or memory problems
- Loss of appetite and weight loss
- Numbness or tingling in arms or legs

As your deficiency grows more severe, the deficiency can progress into one of four types of beriberi:[15]

- Paralytic or nervous beriberi (aka "dry beriberi") — Damage or dysfunction of one or more nerves in your nervous system, resulting in numbness, tingling and/or exaggerated reflexes
- Cardiac ("wet") beriberi — Neurological and cardiovascular issues, including racing heart rate, enlarged heart, edema, breathing problems and heart failure
- Gastrointestinal beriberi — Nausea, vomiting, abdominal pain and lactic acidosis
- Cerebral beriberi — Wernicke's encephalopathy, cerebellar dysfunction causing abnormal eye movements, ataxia (lack of muscle coordination) and cognitive impairments. If left untreated, it can progress to Korsakoff's psychosis, a chronic brain disorder that presents as amnesia, confusion, short-term memory loss, confabulation (fabricated or misinterpreted memories) and in severe cases, seizures

Thiamine is frequently recommended and given to people struggling with alcohol addiction, as alcohol consumption reduces absorption of the vitamin in your gastrointestinal tract. An estimated 80% of alcoholics are deficient in thiamine and therefore more prone to the side effects and conditions above.[16]

Thiamine is also very important for those with autoimmune diseases such as inflammatory bowel disease (IBD) and Hashimoto's (a thyroid autoimmune disorder).[17] In case studies,[18,19] thiamine supplementation has been shown to improve fatigue in autoimmune patients in just a few days.

Interestingly, in one of these studies,[20] which looked at patients with IBD, patients responded favorably to supplementation even though they all had "normal" baseline levels.

The authors speculate that thiamine deficiency symptoms in such cases may be related to enzymatic defects or dysfunction of the thiamine transport mechanism (opposed to

being an absorption problem), which can be overcome by giving large quantities of thiamine.

Thiamine in Infectious Disease

As mentioned earlier, thiamine deficiency has also been implicated in severe infections, including COVID-19. In fact, researchers have noted that, based on what we know about B vitamins' effects on the immune system, supplementation may be a useful adjunct to other COVID-19 prevention and treatment strategies.

More generally, a 2016 study[21] in the journal Psychosomatics sought to investigate the connection between thiamine and infectious disease by looking at 68 patients with Korsakoff syndrome.

Thirty-five of them suffered severe infections during the acute phase of the illness, including meningitis, pneumonia and sepsis, making the authors conclude that "Infections may be the presenting manifestation of thiamine deficiency."

Another study[22] published in 2018 found thiamine helps limit Mycobacterium tuberculosis (MTB) by regulating your innate immunity. According to this paper:

> *"… vitamin B1 promotes the protective immune response to limit the survival of MTB within macrophages and in vivo … Vitamin B1 promotes macrophage polarization into classically activated phenotypes with strong microbicidal activity and enhanced tumor necrosis factor-α and interleukin-6 expression at least in part by promoting nuclear factor-κB signaling.*
>
> *In addition, vitamin B1increases mitochondrial respiration and lipid metabolism … Our data demonstrate important functions of thiamineVB1 in regulating innate immune responses against MTB and reveal novel mechanisms by which vitamin B1 exerts its function in macrophages."*

Thiamine deficiency is also associated with the development of high fever, and according to a letter to the editor,[23] "Is Parenteral Thiamin a Super Antibiotic?" published

in the Annals of Nutrition & Metabolism in 2018, thiamine injections are "likely to eradicate microbial infections" causing the fever.

By dramatically increasing susceptibility to infections, thiamine deficiency could potentially have the ability to impact the spread of just about any pandemic infectious disease — including COVID-19.

Are You Getting Enough B Vitamins?

While biologists struggle to find an ecosystem-wide solution for thiamine deficiency in the food chain, the solution for us, in the meantime, may be to make sure we get enough thiamine through supplementation. Evidence suggests thiamine insufficiency or deficiency can develop in as little as two weeks, as its half-life in your body is only nine to 18 days.[24]

Ideally, you can select a high-quality food-based supplement containing a broad spectrum of B vitamins to avoid creating an imbalance. The following guidelines will also help protect or improve your thiamine status:

- Limit your sugar and refined grain intake — As noted by the World Health Organization,[25] "Thiamine deficiency occurs where the diet consists mainly of milled white cereals, including polished rice, and wheat flour, all very poor sources of thiamine."

  Simple carbs also have antithiaminergic properties,[26] and raise your thiamine requirement for the simple fact that thiamin is used up in the metabolism of glucose.

- Eat fermented foods — The entire B group vitamin series is produced within your gut provided you have a healthy gut microbiome. Eating real food, ideally organic, along with fermented foods will provide your microbiome with important fiber and beneficial bacteria to help optimize your internal vitamin B production as well.

- Avoid excessive alcohol consumption, as alcohol inhibits thiamine absorption, and frequent use of diuretics, as they will cause thiamine-loss.
- Avoid sulfite-rich foods and beverages such as nonorganic processed meats, wine and lager, as sulfites have antithiamine effects.
- Correct any suspected magnesium insufficiency or deficiency, as magnesium is required as a cofactor in the conversion of thiamine.

Daily Intake Recommendations

While individual requirements can vary widely, the typical daily intake recommendations for B vitamins are as follows:

Nutrient	Supplement Recommendations
Thiamine (B1)	Adult men and women need 1.2 and 1.1 mg respectively each day.[27] If you have symptoms of thiamine deficiency, you may need higher doses. Thiamine is water-soluble and nontoxic, even at very high doses, so you're unlikely to do harm. Doses between 3 grams and 8 grams per day have been used in the treatment of Alzheimer's without ill effect.
Riboflavin (B2)	Suggested daily intake is about 1.1 mg for women and 1.3 mg for men.[28]

Nutrient	Supplement Recommendations
Niacin (B3)	The dietary reference intake established by the Food and Nutrition Board ranges from 14 to 18 mg per day for adults. Higher amounts are recommended depending on your condition. For a list of recommended dosages, see the Mayo Clinic's website.[29]
Vitamin B6	Nutritional yeast (not to be confused with Brewer's yeast or other active yeasts) is an excellent source of B vitamins, especially B6.[30] One serving (2 tablespoons) contains nearly 10 mg of vitamin B6, and the daily recommended intake is only 1.3 mg.[31]
B8 (inositol/biotin)	B8 is not recognized as an essential nutrient and no recommended daily intake has been set. That said, it's believed you need about 30 mcg per day.[32] Vitamin B8 is sometimes listed as biotin on supplements. Brewer's yeast is a natural supplemental source.[33]

Nutrient	Supplement Recommendations
Folate (B9)	Folic acid is a synthetic type of B vitamin used in supplements; folate is the natural form found in foods. (Think: Folate comes from foliage, edible leafy plants.) For folic acid to be of use, it must first be activated into its biologically active form (L-5-MTHF). This is the form able to cross the blood-brain barrier to give you the brain benefits noted. Nearly half the population has difficulty converting folic acid into the bioactive form due to a genetic reduction in enzyme activity. For this reason, if you take a B-vitamin supplement, make sure it contains natural folate rather than synthetic folic acid. Nutritional yeast is an excellent source.[34] Adults need about 400 mcg of folate per day.[35]

Nutrient	Supplement Recommendations
Vitamin B12	Nutritional yeast seasoning is also high in B12, and is highly recommended for vegetarians and vegans. One serving (2 tablespoons) provides about 67 mcg of natural vitamin B12.[36] Sublingual (under-the-tongue) fine mist spray or vitamin B12 injections are also effective, as they allow the large B12 molecule to be absorbed directly into your bloodstream.

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