

Some Cases of Diabetes May Simply be a Vitamin B6 Deficiency

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Theme: [Science and Medicine](#)

Global Research, September 25, 2024

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Vitamin B6 plays a crucial role in blood sugar regulation through “first responder” beta cells in the pancreas. Some cases of diabetes may be linked to vitamin B6 deficiency or dysfunction

Vitamin D deficiency is associated with increased risk of Type 2 diabetes. Maintaining adequate vitamin D levels may improve glucose metabolism and reduce diabetes risk

B vitamins, especially B6, B12 and folate, are important for both blood sugar control and mental health. They can help manage diabetes symptoms and reduce anxiety and depression

Minerals like zinc, magnesium and chromium are essential for glycemic regulation and mental well-being. Deficiencies in these minerals are linked to diabetes progression and mood disorders

Mitochondrial health is crucial for preventing chronic diseases like diabetes. Reducing exposure to toxins like seed oils, endocrine disruptors and EMFs can improve cellular energy production and overall health

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Your body’s ability to regulate blood sugar relies on a complex dance between different cells in your pancreas. Research has uncovered a fascinating new player in this intricate process — “first responder” beta cells.¹ These special cells are the quickest to react when glucose levels rise, triggering a cascade of activity throughout your pancreas.

Scientists have found that these first responders have a unique molecular signature, setting them apart from other beta cells.² Intriguingly, they express higher levels of an enzyme called pyridoxamine 5’-phosphate oxidase (PNPO), which is crucial for producing vitamin B6.³

You may have heard of pyridoxal 5’-phosphate (PLP) which differs from pyridoxamine 5’-phosphate oxidase (PNPO). They both are vital for vitamin B6 metabolism, serving different and distinct roles. PNPO is an enzyme that converts other B6 forms into PLP, the active vitamin B6. PLP acts as a coenzyme in many metabolic processes like amino acid metabolism and neurotransmitter synthesis.

PNPO deficiency can lead to vitamin B6-dependent epilepsy, while PLP deficiency causes

various neurological and metabolic issues. PLP is commonly used as a supplement due to its direct involvement in metabolism, whereas PNPO is not supplemented. PLP is light-sensitive and needs careful storage, unlike the stable PNPO enzyme.

This discovery suggests that vitamin B6 may play a more significant role in insulin secretion and blood sugar control than previously thought. By understanding the importance of these first responder cells and their reliance on vitamin B6, researchers are opening up new avenues for diabetes prevention and treatment.

Vitamin B6: The Unsung Hero of Blood Sugar Regulation

The study's findings highlight the critical importance of vitamin B6 in maintaining healthy blood sugar levels. When researchers interfered with vitamin B6 production or function, they observed a dramatic impairment in the pancreas's ability to respond to rising glucose levels.⁴

This effect was seen not only in zebrafish but also in mouse pancreatic tissue, suggesting that the mechanism is likely conserved across species, including humans. The implications of this discovery are profound. It raises the possibility that some cases of diabetes or prediabetes might be rooted in a deficiency or dysfunction related to vitamin B6 metabolism.

This new perspective could lead to more targeted and effective treatments for certain individuals struggling with blood sugar control. Rather than focusing solely on insulin or glucose metabolism, addressing vitamin B6 status could restore normal pancreatic function in some patients.

A New Understanding of Pancreatic Coordination

Your pancreas doesn't just release insulin in a simple, uniform manner. Instead, it relies on a sophisticated hierarchy of cell communication. The research reveals that first responder cells act as leaders, coordinating the activity of surrounding beta cells. This organization allows for a rapid, synchronized response to rising blood sugar levels.

The study used cutting-edge techniques, including optogenetics, to manipulate individual cells within the pancreas of living zebrafish. By activating or silencing specific cells, the scientists could observe how the entire system responded. Remarkably, they found that interfering with just a single first responder cell could disrupt the entire pancreatic response to glucose.⁵

This demonstrates how crucial these vitamin B6-rich cells are to the overall function of your pancreas. Understanding this cellular hierarchy provides new insights into how diabetes might develop and offers potential targets for future treatments. While more research is needed, these findings suggest that ensuring adequate vitamin B6 status could be an important strategy for maintaining healthy blood sugar levels.

For some individuals, addressing a vitamin B6 deficiency might even be enough to restore normal pancreatic function and glucose regulation. Vitamin B6 is found abundantly in animal foods such as organic, pastured beef as well as dark leafy greens, papaya, oranges, cantaloupe and bananas.⁶ Nutritional yeast is another source.

Vitamin D Deficiency: A Hidden Risk Factor for Type 2 Diabetes

Research has also shed light on a fascinating connection between vitamin D levels and Type 2 diabetes.⁷ A study conducted in India examined the relationship between vitamin D and glycosylated hemoglobin (HbA1c), a key marker of long-term blood sugar control. The findings reveal that individuals with Type 2 diabetes tend to have significantly lower vitamin D levels compared to those without the condition.⁸

Further, there's an inverse relationship between vitamin D and HbA1c levels — as vitamin D increases, HbA1c decreases. This suggests that maintaining adequate vitamin D levels may play a crucial role in managing blood sugar and reducing your risk of developing Type 2 diabetes. Sunlight exposure is a primary source of vitamin D, but many people struggle to maintain sufficient levels, even in tropical regions.

Factors such as indoor lifestyles, darker skin pigmentation and limited dietary sources contribute to widespread [vitamin D deficiency](#), making it a global health concern. Vitamin D's importance extends far beyond bone health.

This essential hormone influences many of your bodily functions, including cellular processes, neuromuscular activity and immune function. Deficiency in vitamin D has been linked to a host of health issues, ranging from rickets in children to osteoporosis, [cancer](#)⁹ and autism¹⁰ in adults.

While the exact mechanisms linking vitamin D to glucose metabolism are still being explored, emerging evidence suggests several potential pathways. Vitamin D may improve insulin sensitivity and reduce inflammation, both of which are crucial for maintaining healthy blood sugar levels.¹¹

Vitamin D and Diabetes: Unraveling the Connection

By maintaining optimal vitamin D levels, you may be able to improve your glucose metabolism and reduce your risk of developing this chronic condition. Research has also shown that vitamin D deficiency negatively impacts insulin sensitivity and can directly influence insulin secretion from pancreatic β -cells.¹² Supplementation with vitamin D has been found to significantly improve fasting blood glucose, insulin levels and insulin resistance in diabetic patients.¹³

Moreover, vitamin D's role in modulating inflammation and oxidative stress makes it a key player in both diabetes and mental health in diabetics. In diabetes, vitamin D helps reduce systemic inflammation by hindering nuclear transcription and decreasing cytokine production. This anti-inflammatory effect is crucial, as inflammation is a significant factor in insulin resistance and β -cell dysfunction.¹⁴

People with diabetes are at an increased risk of mental disorders such as depression and anxiety, as well as cognitive decline.¹⁵ Vitamin D's ability to downregulate oxidative stress-related events and influence antioxidant defense mechanisms is beneficial in this respect.

Studies have revealed a shared nutraceutical-gene network module between insulin resistance and depression, suggesting that addressing vitamin D deficiency could potentially prevent both conditions.¹⁶ Regular monitoring of vitamin D levels and appropriate sun exposure and supplementation, if necessary, may be beneficial for individuals at risk of or already dealing with diabetes and mental health issues.

The global prevalence of vitamin D deficiency (defined as a level of less than 20 ng/mL) and insufficiency (defined as a level of 20 to less than 30 ng/mL) is 40% to 100%,¹⁷ so many people are lacking. Globally, 76.6% of adults have vitamin D levels below 30 ng/mL (75 nmol/l).¹⁸

Further, 20 ng/mL has repeatedly been shown to be grossly insufficient for good health and disease prevention, which means the true prevalence of people without optimal levels of vitamin D is even greater. The only way to determine how much sun exposure is enough and/or how much vitamin D3 you need to take is to measure your vitamin D level, ideally twice a year.

Once you've confirmed your vitamin D levels by blood testing, it is important to adjust your sun exposure and/or vitamin D3 supplementation accordingly. Then, remember to retest in three to four months to make sure you've reached your target level.

The optimal level for health and disease prevention is between 60 ng/mL and 80 ng/mL (150 nmol/L to 200 nmol/L), while the cutoff for sufficiency appears to be around 40 ng/mL. In Europe, the measurements you're looking for are 150 nmol/L to 200 nmol/L and 100 nmol/L respectively.

The Power of B Vitamins: More Than Just Blood Sugar Control

While vitamin B6 takes center stage in diabetes management, the entire B vitamin complex plays an important role in both blood sugar regulation and mental health. Recent studies have shown that B vitamins, particularly B6, B12 and folate, are essential for optimal brain function and the production of neurotransmitters like dopamine and GABA.¹⁹

A deficiency in these micronutrients has been linked to neurological disorders, including anxiety and depression,²⁰ while high doses of vitamin B6 supplements have been found to significantly reduce anxiety, stress and depression symptoms. One study reported that adults supplementing with 25 milligrams (mg) of vitamin B6 twice daily for six months experienced improved mental well-being.²¹

Additionally, vitamin B6 has been found to effectively lower blood glucose levels in gestational diabetes and reduce postprandial blood glucose levels after consuming carbohydrates by inhibiting small-intestinal α -glucosidase enzyme activity.²² Furthermore, B vitamin complex supplementation has demonstrated the ability to enhance glycemic control and renal function in diabetic patients by reducing homocysteine levels.²³

The Balancing Act of Minerals: Zinc, Magnesium and Chromium

Minerals play a vital role in maintaining both blood sugar balance and mental health. Zinc, for instance, is crucial for glycemic regulation and immune function. Studies have shown

that zinc supplementation can improve fasting glucose concentrations and protect against oxidative damage in diabetes.²⁴ Additionally, zinc deficiency has been linked to depression and anxiety, as zinc-containing neurons are found in brain regions affecting mood and cognitive ability.²⁵

[Magnesium](#), another essential mineral, is involved in over 300 enzymatic reactions, including those related to glucose metabolism. Hypomagnesemia, or low levels of magnesium, is strongly associated with Type 2 diabetes and can lead to more rapid disease progression. Magnesium supplementation, meanwhile, has been shown to enhance insulin sensitivity in diabetic patients and improve symptoms of depression and anxiety.²⁶

Chromium, while less studied, has also shown promise in both diabetes management and mental health. Low chromium levels are associated with an increased risk of diabetes and elevated inflammation.²⁷

Supplementation with chromium has been found to improve glycemic control and reduce carbohydrate cravings and mood swings in individuals with depressive symptoms.²⁸ By ensuring adequate intake of these trace minerals through diet or targeted supplementation, you may be able to support both your blood sugar control and mental well-being.

Mitochondrial Health Is an Overlooked Key to Preventing Chronic Diseases Like Diabetes

The rise in chronic diseases, including diabetes, may be linked to more than just nutrient deficiencies like vitamin B6 and vitamin D. Three major mitochondrial toxins — [linoleic acid](#) in seed oils, [endocrine-disrupting chemicals](#) (EDCs) in plastics and other consumer products, and electromagnetic fields (EMFs) — play a significant role in compromising cellular energy production.

These toxins create an environment in the gut that favors endotoxin-producing bacteria, potentially contributing to a wide range of diseases including heart disease, cancer and obesity. The key to addressing these issues lies in restoring healthy energy production at the cellular level, which in turn helps maintain proper gut flora balance.

Contrary to popular belief, glucose is actually a superior fuel for your body compared to dietary fat. While refined sugar in large quantities is unhealthy, it's less harmful than [polyunsaturated fats](#) (PUFAs) found in seed oils. Eliminating these oils, which are prevalent in ultraprocessed foods, is crucial for optimal health.

Excessive fat intake can lead your body to favor fat metabolism over glucose metabolism, resulting in suboptimal energy production. This is significant because every bodily process relies on adequate energy availability. By focusing on [increasing mitochondrial energy production](#), many health issues can be addressed naturally.

Industrial toxins, like omega-6 fats from vegetable and seed oils, plastics with estrogen-like additives and EMFs, severely impact mitochondrial energy production. Addressing these factors, along with nutrient deficiencies like vitamin B6, vitamin D and trace minerals, may be key in preventing and managing chronic diseases, including diabetes.

Tired of Guessing About Your Health? Your Path to Clarity Starts with HOMA-IR

Are you insulin resistant? The HOMA-IR test is a powerful tool to determine this. Developed in 1985, the HOMA-IR test combines fasting glucose and insulin levels to give us a clear picture of how well your body responds to insulin. It's a reliable and practical test for insulin resistance and prediabetes.

What sets the HOMA-IR apart is its accessibility and reliability. Unlike complex, invasive procedures, this test needs only a blood draw. This makes it convenient for patients and practical for use in clinics. The HOMA-IR gives a clear measure of insulin resistance. It helps people and doctors spot metabolic issues early and track improvements over time. The HOMA-IR formula is as follows:

HOMA-IR = (Fasting Glucose x Fasting Insulin) / 405, where

- Fasting glucose is measured in mg/dL
- Fasting insulin is measured in $\mu\text{IU/mL}$ (microinternational units per milliliter), and
- 405 is a constant that normalizes the values

If you're using mmol/L for glucose instead of mg/dL, the formula changes slightly:

HOMA-IR = (Fasting Glucose x Fasting Insulin) / 22.5, where

- Fasting glucose is measured in mmol/L
- Fasting insulin is measured in $\mu\text{IU/mL}$, and
- 22.5 is the normalizing factor for this unit of measurement

So, what's considered a healthy HOMA-IR score? Anything below 1.0. If you're above that, you're considered insulin resistant. The higher your values, the greater your insulin resistance. Conversely the lower your HOMA-IR score, the less insulin resistance you have, assuming you are not a Type 1 diabetic who makes no insulin. Insulin resistance often exists long before obvious signs of trouble, silently disrupting your body's balance and setting the stage for serious conditions later.

Incidentally, my personal HOMA-IR score is 0.2, which is incredibly low. In fact, it's the lowest Dr. Cate Shanahan, who introduced me to HOMA-IR, has ever seen. The reason for this is that my body became more efficient at burning fuel, due to the increased availability of glucose. I consumed extra carbohydrates, which gave my cells energy. They could function better, which improved my metabolic health.

The Revolutionary Path to Healing and Longevity

For the last 50 years, I have been in a relentless pursuit of how to optimize health and wellness and prevent disease. Every year I get closer to the truth. But this time, I am convinced I have finally uncovered the kernels of truth that will help nearly everyone recover from whatever physical illness they are suffering with.

I've uncovered a groundbreaking revelation that has the astounding capacity to transform global health and that is the power of cellular energy. This isn't just another health trend; it's the fundamental key to unlocking your body's innate healing abilities and achieving

lasting vitality.

The Hidden Health Crisis

Nearly everyone reading this is only making about one-third of the energy they require to reverse disease and power their body to regenerate and repair damaged cells. Nearly all of us are in the black hole of self-perpetuating destruction of our gut bacteria that are crucial to help us regain our full energy potential.

Here's a startling fact: A very sensitive and inexpensive blood test shows us that over 99% of us have insulin resistance, and as a result, are unknowingly living with compromised cellular energy. This silent epidemic explains why millions struggle with persistent health issues, feeling trapped in a cycle of treatments that never quite solves the problem. But there's hope, and it lies within your very cells.

Imagine a life where your body hums with energy, where healing happens naturally, and where age is just a number. This isn't a far-off dream — it's the reality that I have been experiencing for over a year now and awaits when you master the art of cellular health.

Introducing 'Your Guide to Cellular Health'

My newest book, "Your Guide to Cellular Health: Unlocking the Science of Longevity and Joy" is not just a manual — it's your passport to a revolution in personal wellness. This comprehensive guide will empower you with life-changing knowledge:

- Discover how to fuel your mitochondria for boundless energy and rapid healing
- Uncover the secrets of metabolism that keep you vibrant and resilient against aging and disease
- Identify and eliminate the three primary mitochondrial saboteurs lurking in your environment
- Master innovative cutting-edge lifestyle and dietary strategies that supercharge your cellular energy production

This isn't about quick fixes or temporary solutions. It's about fundamentally transforming your health at its very foundation — your cells.

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Notes

^{1, 2, 3, 4, 5} [Science Advances, June 26, 2024](#)

⁶ [Harvard TH Chan, The Nutrition Source: Vitamin B6](#)

^{7, 8, 11} [Apollo Medicine, April 2024](#)

⁹ [World J Gastrointest Oncol. 2024 Jun 15;16\(6\):2394-2403. doi: 10.4251/wjgo.v16.i6.2394](#)

¹⁰ [Cureus. 2023 Oct 26;15\(10\):e47716. doi: 10.7759/cureus.47716. eCollection 2023 Oct](#)

^{12, 13, 14, 15, 16, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28} [Nutrients. 2023 Sep; 15\(18\): 3929](#)

¹⁷ [Endocr Pract. 2021 May; 27\(5\): 484-493, Introduction](#)

¹⁸ [Frontiers in Nutrition, March 16, 2023](#)

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