VITAMINS

DNA Wellness Report

DCB_Vitamins_20190228

Report Summary for
DCB_Vitamins_20190228

Reported traits		Your SNP based summary
Vitamin A	Retinoids and Carotenoids	Moderately Increased Risk of Vitamin A Deficiency
Vitamin B9	Folate and Folic Acid	Moderately Increased Risk of Vitamin B9 Deficiency
Vitamin B12	Cobalamins	Typical Risk of Vitamin B12 Deficiency
Vitamin C	Ascorbic Acid	Typical Risk of Vitamin C Deficiency
Vitamin D	Vitamin D2 and D3	Typical Risk of Vitamin D Deficiency
Vitamin E	Tocopherols and Tocotrienols	Slightly Decreased Risk of Vitamin E Deficiency
Vitamin K	Vitamin K1	Typical Risk of Vitamin K1 Deficiency

The above table includes information about your genotype and associated deficiency risk scores for each **vitamin** included in this report. Note that this risk estimate is solely based on the selected genetic variants (SNPs) analyzed in this report and your genotype file may not contain all of the SNPs referenced in the report. This document is not diagnostic or conclusively predictive and any concerns or lifestyle changes should always be discussed with a healthcare professional first.

Nonetheless, the combination of personalized genetic analysis and optimal lifestyle choices provides a new and powerful approach to reducing your risk for **vitamin deficiencies** in the long run and can help you make the best and most well-educated decisions about your health. Read on to get a more in-depth look at how your genes can help you achieve optimal health!

Top Suggestions

The following are the top suggestions made in this report. We have taken your genetic makeup into consideration when identifying these. Please remember to consult a health professional first if you have any concerns. For a full list of your prioritized recommendations skip to the Conclusion section.

1. **Ensure your diet contains sufficient amounts of vitamin A from both animal (retinoids: beef liver, salmon, and tuna) and plant (caretinoids: spinach, sweet potatoes, and carrots) sources.**
2. **Ensure your diet contains sufficient amounts of vitamin B9 (folate) from foods such as green vegetables.**
3. **If you are not getting enough vitamin A in your diet, consider taking a vitamin A (retinol not beta-carotene) supplement.**

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Welcome to your Vitamins DNA Wellness Report

Welcome to your SelfDecode Vitamins DNA Wellness Report!

The goals of this report are to:

1. **Present you with general information about genetics, nutrients, and vitamins.**
2. **Highlight genes and genetic variations that have been associated with vitamin status.**
3. **Educate you about how your genetic make-up may be affecting the way your body processes and uses vitamins.**
4. **Empower you to make informed decisions about your diet and lifestyle.**
5. **Provide you with insight into which vitamins and vitamin supplements may benefit you most.**

6. Show you how SelfDecode's DNA Wellness Reports can help you achieve optimal health and wellness.

Overall, this report includes information about how your body utilizes Vitamins. First, we carefully look at the scientific literature for any genetic variations that have been associated with traits related vitamin utilization. We then use your personal genotype file and create this report based on what your unique genetic make-up says about each individual trait. Using this analysis, we provide useful tips and suggestions, including personalized diet, lifestyle, and supplement recommendations, to help you improve your long-term health and wellness.

Introduction

Nutrient Overview

Nutrients are vital to our existence. They provide the raw materials our bodies need to grow, survive, and be healthy. We get the vast majority of our nutrients -- including vitamins, minerals, amino acids/proteins, fatty acids, and carbohydrates -- from food we eat and the supplements we take.

The food you eat passes from the stomach to the small intestine, where most nutrients are **absorbed** into the bloodstream. Once in the bloodstream they are **distributed** throughout the body to perform a variety of essential functions. After their job is done, these various nutrients are **metabolized** (broken down) and finally **excreted**.

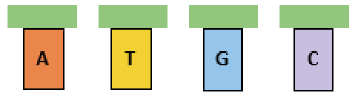
Some nutrients are inactive until the body modifies or converts them into their active form. For instance, many different **enzymes** are involved in the process of converting **provitamins** (the inactive form of vitamins) into their active state. It is these active forms that then carry out the many important functions that vitamins perform throughout the body [1].

Our genetics can have a profound influence on the way our bodies utilize nutrients. In fact, our genes impact how nutrients are used from the moment we consume them until the time we get rid of them. **The scientific study of this process is called nutrigenetics**. Individual variability can make a significant difference in how people respond to different nutrients -- and nutrigenetics makes it possible to develop personalized recommendations and suggestions based on each person's unique genetic make-up [1].

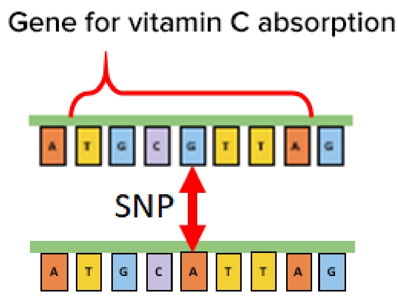
The journey into understanding how our genes shape the way we respond to nutrients is only just beginning, and new discoveries about the human genome are continually providing valuable insights into the science of personalized nutrition. Because these scientific discoveries are ongoing, this report is not a comprehensive list of all of the SNPs associated with vitamin processing and use, as there are many genetic variations yet to be discovered! **Nonetheless, we here at SelfDecode are always striving to provide the most up-to-date, in-depth, and comprehensive information to help you achieve optimal health and wellness** -- and so we'll be constantly updating our **DNA Wellness Reports** as research continues to advance.

How This Report Works

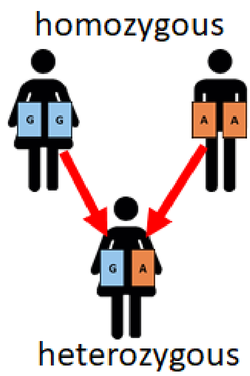
Your DNA is a like a long string packed into every cell in your body. Along this string are “**bases**”, lined up like beads. There are four bases marked by the letters: **A**, **G**, **C**, and **T**. These align in very specific sequences to create genes. Your unique genetic makeup is stored in the sequence of these bases.



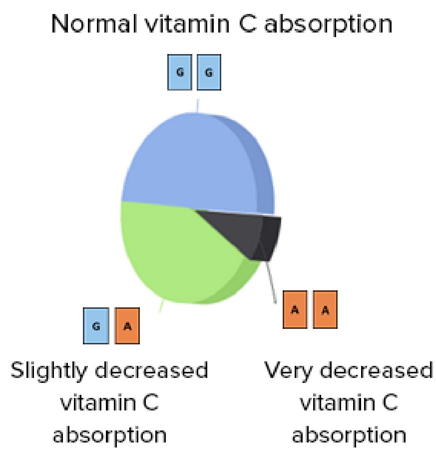
The sequence formed by these bases varies between people. For example, at a specific location in a sequence, 75% of the population might have a “G”, while the other 25% may have an “A”. The difference is only one base, so this type of genetic variation is called a **Single Nucleotide Polymorphism** or **SNP** (pronounced “snip”). In this example, the SNP has only two possible variations: “G” or “A”.



You inherit two copies of each gene: one from your mother, and one from your father. In the case of the example SNP above, if you were to carry one of each variant (e.g. “AG”), you would be considered **heterozygous** for this SNP. If you carried two of the same copies (“GG” or “AA”), you would be **homozygous** for this SNP. These two-letter designations are your **genotype** for a specific gene.

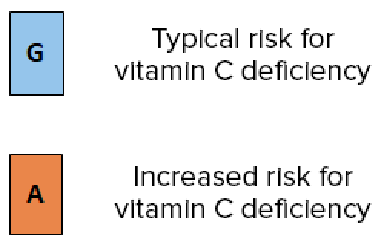


We can extend our example by pretending that the gene in the above example is involved in a biological function, such as your ability to absorb vitamin C from your diet. People with the “**G**” **variant** might have a version of the gene that absorbs vitamin C at a normal rate, while people with the “**A**” **variant** might have a copy that absorbs vitamin C at a much slower rate. This would mean that people with the “A” version would tend to get less vitamin C from their diet, which would increase their risk of developing vitamin C deficiency.



Now you see how having access to this knowledge can empower people to take steps to stay healthy. In our example, someone who knew they had the “AA” genotype could use this information to make lifestyle adjustments to increase vitamin C in their diet.

For this report we discuss SNPs that have been associated with vitamin levels.



Some Caveats to Consider

Before we get started, there are **three important points to keep in mind** as you read through your results:

1. Your environment plays a major role in determining if you develop a trait or not.

While your genetic information is very valuable, it is only one piece of the puzzle. The way you interact with your environment can have a profound impact on your health, and many different factors -- such as diet, exercise, smoking or drinking, pollution, and even the amount of social interaction you get -- all have the potential to override any genetic risk factors you might have! Nonetheless, knowing your genetic make-up is one of the best ways to educate yourself about what lifestyle choices can help you maximize your long-term health and well-being.

2. Risk factors are a sum of averages.

Because of how scientific studies are conducted, the degree of risk associated with any specific SNP has to be determined by averaging together data from many different study participants. The exact amount of risk for any single individual, however, is unknown. There are also many individual SNPs that may contribute to a single trait or function -- and some of these SNPs might increase risk for a trait, while others may decrease it.

In our gene reports, we take into consideration as many SNPs as possible when determining your risk of a particular trait, and give you detailed breakdowns of each SNP in the tables in each section below. This gives you the most accurate picture of how your genetic profile relates to specific traits.

3. The data that we analyze is only a portion of your genetic make-up.

It is important to remember that the genotype file you provide us with only covers a very small proportion of your entire genome (about 0.05% for a typical 23andMe file). You will carry many more genetic variations than just the ones we report on here, and these can potentially have a strong impact on your predisposition towards certain traits. As the field of genetics progresses, more and more of your genome will become accessible and able to be analyzed.

That being said, we analyze the most widely-studied and well-understood genetic variants currently known to science. Our databases are constantly being updated and expanded. We will continue to update this report to ensure the most accurate information available is used to help you make informed decisions about your health.

With these points in mind, you are now ready to read on and learn all about your genes, the impact they are having on your health, and how you can take advantage of all this information!

What Are Vitamins?

Vitamins are essential nutrients that keep our bodies in optimal health. Although we get most of our vitamins either from our diet or from supplements, a few can also be produced in the body: examples include vitamin D3 (also known as cholecalciferol, which can be produced in the skin) and vitamin K2 (also known as menaquinone, which can be produced by bacteria in your gut) [2].

Water-soluble vitamins are not stored in the body, so they must be consumed daily in our diets. The one exception to this is vitamin B12, which can be stored in the liver. In contrast, **fat-soluble vitamins can be stored in the body**, most commonly in the liver. For this reason, fat-soluble vitamins do not need to be consumed in the diet every day, however, maintaining a consistent, balanced daily diet is best for overall health [3, 4].

Many people suffer from vitamin deficiencies all over the world, and they can be found in men and women of all ages and ethnicities. As we age, vitamin deficiencies become even more prevalent, due to insufficient nutrition, poor absorption, or an existing condition [5].

Maintaining normal, or ideally, optimal levels of vitamins in your body will help to prevent deficiencies, keep you healthy, and empower you to perform at your best!

If you are interested in monitoring your vitamin levels, take a look at the **Lab Test Analyzer (LTA)**! This **affordable** and **easy-to-use** tool can help you keep your vitamin levels within an optimal range by allowing you to track their levels over time, identify the causes of abnormal levels, and will even give you **personalized, evidence-based** lifestyle, diet, and supplement recommendations.

The table on the following page is a comprehensive list of vitamins, their solubility characteristics, and food sources:

Vitamins Wellness Food List

Vitamin	Solubility	Food Sources
Vitamin A (retinoids)	Fat-soluble	beef liver, salmon, tuna, eggs, butter, and ghee
Vitamin A (carotenoids)	Fat-soluble	spinach, kale, amaranth, chard, broccoli, carrots, sweet potatoes, squash, pumpkin, sweet peppers, cantaloupe, and mangos
Vitamin B9 (folate)	Water-soluble	beef and chicken liver, spinach, asparagus, broccoli, brussel sprouts, romaine lettuce, green peas, kidney beans, black-eyed peas, and avocados
Vitamin B12 (cobalamin)	Water-soluble	beef, beef liver, clams, trout, salmon, tuna, haddock, milk, eggs, cheese, yogurt, chicken, dried green and purple lavers (nori), and black trumpet and golden chanterelle mushrooms
Vitamin C (ascorbic acid)	Water-soluble	oranges, kiwi, grapefruit, strawberries, cantaloupe, pineapple, broccoli, green/red peppers, brussel sprouts, tomatoes, green peas, cauliflower, cabbage, and potatoes
Vitamin D2 (ergocalciferol)	Fat-soluble	fortified foods such as cereals, breads, milk, yogurt, and orange juice
Vitamin D3 (cholecalciferol)	Fat-soluble	salmon, tuna, cod liver oil, sardines, and eggs
Vitamin E (tocopherols and tocotrienols)	Fat-soluble	sunflower seeds, almonds, hazelnuts, and peanuts/peanut butter, oils (safflower oil, sunflower oil, and corn oil), and green leafy vegetables
Vitamin K1 (phylloquinone)	Fat-soluble	turnips greens, collard greens, spinach, kale, broccoli, edamame, soybeans, carrot juice, pomegranate juice, okra, Caesar salad dressing, blueberries, and grapes
Vitamin K2 (menaquinones)	Fat-soluble	natto (fermented soybeans), chicken, ground beef, and cheese

References: 6, 7, 8, 9, 10, 11, 12, 13, 14

Vitamin A

Retinoids and Carotenoids

Vitamin A exists in two main dietary forms: retinoids and carotenoids. Retinoids, such as retinol, are fat-soluble, and can be found in animal products such as meat and eggs. Carotenoids, such as beta carotene, are water-soluble, and can be found in plant products such as fruits and vegetables. Although retinol is considered to be “active” or "pre-formed", our bodies still must convert it into **retinoic acid, the biologically active form of vitamin A**. We also have the ability to convert carotenoids (also known as provitamin A) into retinoic acid [15, 16].

Carotenoids are pigments that give plants their green, red, or orange color, and main sources include plants, such as leafy greens (spinach, kale), carrots, sweet potatoes, and squash [6].

Overall, vitamin A is required for growth and development, the immune system, vision, and fat metabolism. We need to take in both retinoids and carotenoids through our diet or supplementation. Low vitamin A levels can contribute to Th17 dominance, autoimmunity, leaky gut (increased intestinal permeability), and compromise the skin and mucosal tissue [15, 17].

The BCO1 gene is responsible for making a protein (BCMO1) that is involved in the **conversion of beta-carotene into retinoic acid (active form of vitamin A)** that can be used by the body. As beta-carotene is the main source of vitamin A in plants, SNPs in the BCO1 gene can impact how well we convert carotenoids from plant-based sources. Genetic variations for five SNPs (rs6420424, rs6564851, rs12934922, rs7501331, and rs11645428) have been associated with decreased beta-carotene conversion, which may lead to lower levels of active vitamin A [18, 19].

Retinol is stored in the liver, and two genes RBP4 and TTN are involved in **the transport of retinol from the liver to the rest of the body**. Genetic variations for rs10882272 (in the RBP4 gene) and rs1667255 (in the TTN gene) have each been associated with decreased and increased levels of retinol, respectively [20, 16].

Vitamin A Related SNPs

SNP	Your Genotype	Associations	Reference
rs10882272	CT	Slightly Decreased Levels of Active Vitamin A	20
rs11645428	GG	Highly Decreased Levels of Active Vitamin A	18
rs12934922	AA	Typical Levels of Active Vitamin A	19
rs6420424	AA	Typical Levels of Active Vitamin A	18
rs6564851	GG	Highly Decreased Levels of Active Vitamin A	18
rs7501331	TC	Slightly Decreased Levels of Active Vitamin A	19

Your genotypes for the SNPs analyzed in this section indicate that you have a moderately above-average risk of vitamin A deficiency. To reduce your risk of vitamin A deficiency, you may want to consider the following recommendations:

(1) If you are not a vegetarian, consume higher amounts of retinoids (retinol) from animal sources such as beef liver, salmon, and tuna.

(2) Most people with lower BCO1/BCMO1 activity will not respond well to more carotenes and consuming higher amounts can have negative effects, especially in people who smoke [21]. If you are a vegetarian or vegan, and believe you will not be able to get enough retinoids (retinol) from the foods you eat, consider taking a supplement that contains retinol only in the form of retinyl palmitate. Another option for non-vegetarians and non-vegans are retinol only supplements that contain retinyl acetate such as Fish or Cod Liver Oil. If you do decide to supplement, be sure to take the recommended dose, and consult with your doctor. Excess retinol in your body can be toxic, especially during pregnancy, for both mother and child [22, 23]. Vitamin A is a fat-soluble vitamin, so take vitamin A supplements with a meal containing some fat for better results.

(3) Avoid consuming alcohol. Drinking decreases retinol and retinol-binding protein (RBP4) levels in the body, which can increase your risk of deficiency [24].

(4) Cigarette smoking can decrease vitamin A levels, so quitting smoking will not only provide general health benefits, but can help you maintain healthy levels of vitamin A in your body [25].

Over-the-counter (OTC) supplements can contain retinoids (retinol) only (usually in the form of natural retinyl acetate or synthetic retinyl palmitate), carotenoids only (usually in the form of beta-carotene), or a mixture of both. In regard to effectiveness, no differences have been observed between consuming non-synthetic and synthetic forms of vitamin A. Again, if you decide to start taking vitamin A supplements, always use caution and consult with your healthcare provider before starting any regimen. It would also be beneficial to monitor your levels using a tool such as the Lab Test Analyzer to make sure your levels are in the optimal range.

For more information on vitamin A, read this SelfHacked post.

Vitamin B9

Folate and Folic Acid

Vitamin B9 -- also known as folate or folic acid -- is involved in the creation and methylation of DNA, as well as amino acid metabolism, which allows our body to create proteins. It also acts as an antioxidant, and plays an important role in the formation of red blood cells. Women are more likely to be deficient in vitamin B9 than men, and this vitamin is particularly important during pregnancy, as B9 deficiencies can lead to birth defects. In addition, low B9 is associated with high homocysteine levels, which can lead to heart disease and stroke [26, 27, 28, 29, 30, 31].

Before vitamin B9 can be used as a co-factor for chemical reactions throughout the body, **our bodies need to convert folate or folic acid into the active form of vitamin B9, l-methylfolate (5-MTHF).** This process involves the key enzyme, MTHFR [32, 33].

Vitamin B9 is not created in our bodies, so it must be taken in either from food or through supplementation. **Folate is the natural form** of vitamin B9 found in food, whereas **folic acid is the synthetic form** found in most fortified foods and supplements. Common foods that contain high amounts of folate include vegetables such as beef liver, spinach, collard greens, asparagus, broccoli, and brussel sprouts. Cooking foods can break down as much as 90% of their vitamin B9, so it is best to eat raw vegetables [34, 35, 9, 30].

Two SNPs commonly associated with MTHFR (rs1801131 and rs1801133) have been reported to reduce folate conversion to l-methylfolate. This means that genetic variations in one or more of these genes can lead to decreased levels of active vitamin B9 (l-methylfolate) in the body [29, 33].

Two genes SLC19A1 and FOLH1 are involved in the movement of folate into cells throughout the body. Two respective SNPs rs1051266 and rs202712 have been associated with altered vitamin B9 (folate) levels in the blood [36, 37].

Vitamin B9 Related SNPs

SNP	Your Genotype	Associations	Reference
rs1801131	TG	Moderately Decreased Levels of Active Vitamin B9	38
rs1801133	AG	Moderately Decreased Levels of Active Vitamin B9	33
rs1051266	Not Reported	No Data Available	36

Your genotypes for the SNPs analyzed in this section indicate that you have a moderately above-average risk of vitamin B9 deficiency. To reduce your risk of vitamin B9 deficiency, you may want to consider the following recommendations:

(1) Consume higher amounts of vitamin B9 (folate) from foods such as green vegetable. We do NOT recommend consuming vitamin B9 in the form of folic acid (synthetic), which is commonly found in fortifed foods and vitamin B9 supplements. In addition, folic acid is not absorbed as well as folate, so it is best to get your vitamin B9 from natural sources [39]. Another option would be to take supplements that contain active vitamin B9 (l-methylfolate) if you think you are not getting enough vitamin B9 (folate) in your diet. Importantly, by taking l-methylfolate supplements you are directly taking the active form of vitamin B9, bypassing the problematic activation step (by MTHFR) [39].

(2) Avoid consuming excessive amounts of alcohol, as alcohol has been shown decrease vitamin B9 levels in the body [40].

(3) Cigarette smoking decreases levels of vitamin B9 in the body, so limiting or quiting smoking will not only provide overall health benefits, but will also help you maintain healthy levels of vitamin B9 [41].

(4) Short-acting antacids (Tums, Rolaids) that contain calcium carbonate and H2 antagonists such as ranitidine (Zantac), famotidine (Pepcid), and cimetidine (Tagamet) can reduce acid and increase pH in the small intestine, leading to decreased absorption of dietary folate and/or folic acid. Ideally, it would be best to avoid taking any of these products prior to or during a meal [42].

Over-the-counter (OTC) supplements (and many fortified foods) contain either folic acid, the synthetic form of vitamin B9, or active vitamin B9 (l-methylfolate). Folic acid is not absorbed as well as folate, so it is best to get your vitamin B9 from natural sources [39, 43].

For more information on vitamin B9, read this SelfHacked post.

Vitamin B12

Cobalamins

Vitamin B12 (cobalamin) exists in four subtypes: cyanocobalamin, hydroxocobalamin, methylcobalamin, and adenosylcobalamin. **Cyanocobalamin (a synthetic form of B12) and hydroxocobalamin (a natural form of B12) must be converted by the body into the biologically active forms (methylcobalamin or adenosylcobalamin)** [44].

Cyanocobalamin is used to "fortify" foods (enhance their nutritional value), and it is the most common (and least expensive) type found in oral supplements. The other three types of vitamin B12 are naturally found in a variety of foods, and are also available in some vitamin B supplements. Together, the different forms of vitamin B12 are crucial for energy production, DNA synthesis, red blood cell formation, and for the insulation of brain cells (myelin formation) [44, 45].

Since vitamin B12 is not created in our bodies, it must be obtained either through food or by taking supplements. Meats that contain the highest amounts of natural and active vitamin B12 include beef, liver, clams, trout, and salmon. Vitamin B12 is also found in some plant sources including dried green and purple lavers (nori) as well as black trumpet and golden chanterelle mushrooms. Additional sources of vitamin B12 include dairy products such as milk, cheese, and yogurt, or through supplements [46, 47, 48, 10].

The genes FUT2, FUT6, TCN1, TCN2, and CUBN influence how well our small intestine absorbs vitamin B12. Both FUT2 and FUT6 form an enzyme that alters proteins to create a more hospitable environment for gut flora (the "good" bacteria that live in your digestive tract). TCN1, TCN2, CUBN form proteins that enable vitamin B12 to be transported into cells. The MUT gene product (vitamin B12 dependent) is involved in the formation of succinyl-CoA, an important part of the Krebs cycle (involved in energy production). Genetic variations for four SNPs in the FUT2 gene (rs602662, rs492602, rs281379, and rs601338) and two SNPs in the FUT6 gene (rs708686, and rs3760776) are associated with altered vitamin B12 levels. Genetic variations for two SNPs in the TCN1 gene (rs34324219 and rs526934), one SNP in the TCN2 gene (rs1131603), and three SNPs in the CUBN gene (rs1801222, rs11254363, and rs12780845) have been reported to affect vitamin B12 levels [49, 50, 51, 52, 53].

Vitamin B12 Related SNPs

SNP	Your Genotype	Associations	Reference
rs1801222	AA	Slightly Decreased Levels of Vitamin B12	53
rs3760776	AG	Slightly Increased Levels of Vitamin B12	53
rs492602	AA	Typical Levels of Vitamin B12	54
rs526934	GG	Slightly Decreased Levels of Vitamin B12	53
rs601338	GG	Slightly Decreased Levels of Vitamin B12	53
rs602662	GG	Typical Levels of Vitamin B12	55

Your genotypes for the SNPs analyzed in this section indicate that you have an average risk of vitamin B12 deficiency. To reduce your risk of vitamin B12 deficiency, you may want to consider the following recommendations:

(1) If you are not a vegetarian, consume higher amounts of vitamin B12, which you can get from foods such as beef, seafood, and chicken.

(2) If you are a vegetarian or vegan, you can get more vitamin B12 from foods such as dried green and purple lavers (nori). Alternatively, you may want to consider supplementation. If you are a non-vegetarian that may not getting enough vitamin B12 in your diet, you also may want to consider supplementation.

(3) Drinking alcohol can deplete vitamin B12 levels in the body, so it would also be a good idea to limit your alcohol intake [56].

(4) Long-term use of short-acting antacids including H2 antagonists such as ranitidine (Zantac), famotidine (Pepcid), and cimetidine (Tagamet) and long-acting antacids including proton pump inhibitors such as omeprazole (Prilosec), lansoprazole (Prevacid), pantoprazole (Protonix), esomeprazole (Nexium), and rabeprazole (Aciphex) can reduce acid and increase pH in the small intestine, leading to decreased absorption of dietary vitamin B12. If you are taking any short-acting antacids it would be best to avoid taking them prior to or during a meal. If you are taking a long-acting antacid please consult with your doctor if you are concerned about the risk of vitamin B12 deficiency [57, 58].

Over-the-counter (OTC) supplements (and many fortified foods) contain cyanocobalamin, the synthetic form of vitamin B12. Other supplements contain the natural or biologically active forms hydroxocobalamin, methylcobalamin, or adenosylcobalamin. Supplements containing these natural or biologically active forms of vitamin B12 offer greater benefits than those containing cyanocobalamin [47]. Vitamin B12 is also available as sublingual (under the tongue) tablets, intramuscular (IM) injections, and intravenous (IV) drips for those with absorption issues. It would also be beneficial to monitor your levels using a tool such as the Lab Test Analyzer to make sure your levels are in the optimal range.

For more information on vitamin B12, read this SelfHacked post.

Vitamin C

Ascorbic Acid

Vitamin C -- also known as **ascorbic acid** -- is a potent antioxidant and is important for immunity, repair, and overall health. It is also crucial for energy use, neurotransmitter synthesis (catecholamines such as norepinephrine and dopamine), and helps makes carnitine, which is important for fat burning and energy production. Finally, vitamin C maintains healthy skin, joints, and red blood cells, as it is essential for producing collagen and absorbing iron. Vitamin C deficiency is commonly known as scurvy, a disorder that can result in weakness, fatigue, bruising, and bleeding gums [59, 60].

Vitamin C is not created in our bodies, so it must be taken in from food or through supplementation. Vitamin C can be naturally found in many vegetables and fruits, especially in oranges, kiwi, grapefruit, and strawberries [11].

The genes SLC23A1 and SLC23A2 affect vitamin C absorption in the small intestine. Genetic variations for the SNPs rs33972313 and rs11950646 (in the SLC23A1 gene) have been associated with decreased vitamin C levels, whereas genetic variants for the SNPs rs10063949 (in the SLC23A1 gene) as well as rs6053005 and rs6133175 (in the SLC23A2 gene) have been associated with increased vitamin C levels [61, 62, 63, 64, 65, 66].

Vitamin C Related SNPs

SNP	Your Genotype	Associations	Reference
rs6133175	AG	Typical Levels of Vitamin C	66
rs10063949	Not Reported	No Data Available	65
rs11950646	Not Reported	No Data Available	66

Your genotypes for the SNPs analyzed in this section indicate that you have an average risk of vitamin C deficiency. To reduce your risk of vitamin C deficiency, you may want to consider the following recommendations:

(1) Consume higher amounts of vitamin C, which can be found in foods such as leafy green vegetables, as well as in fruits such as oranges, kiwi, grapefruit, and strawberries. Excess heat can actually degrade vitamin C to the point where it will not be able to be used by your body, so try not to over-heat vegetables when cooking them [67].

(2) If you are not getting enough vitamin C from your diet, consider taking a vitamin C supplement.

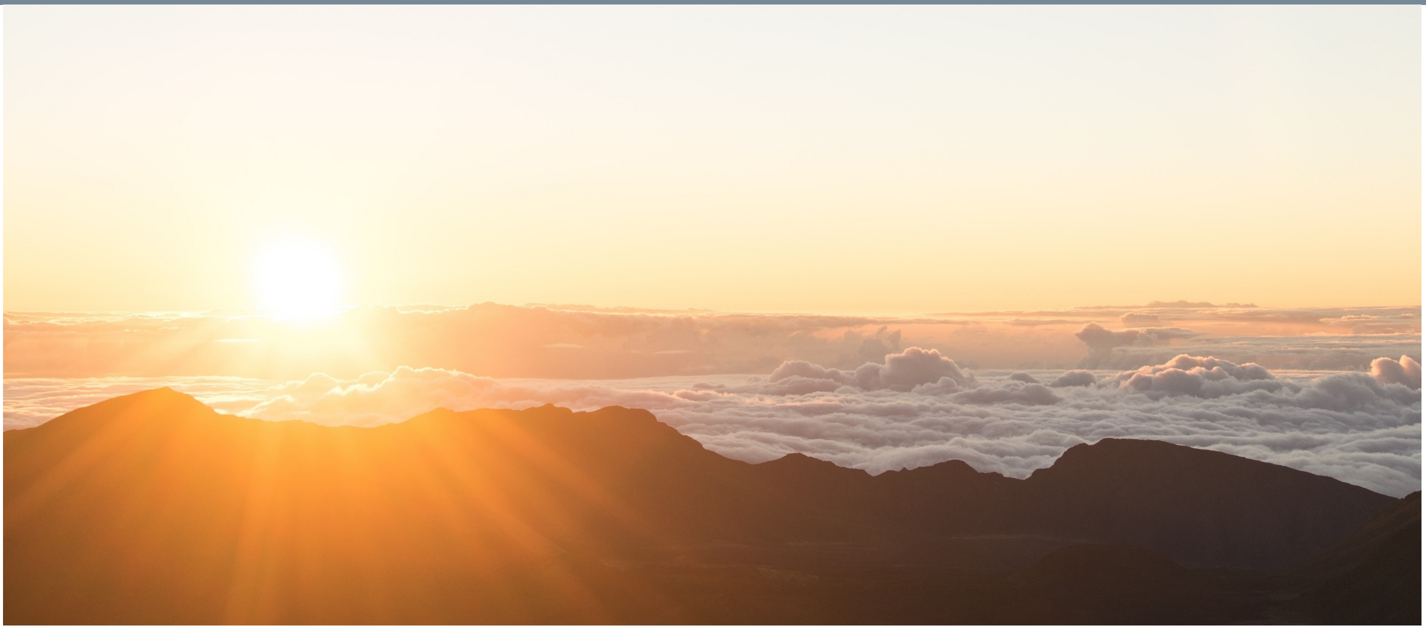
(3) People with inflammatory gut conditions, such as Crohn's disease and celiac disease, may have a reduced ability to absorb vitamin C; so please keep this in mind if you suffer from one of these conditions [68].

(4) Chronic alcohol consumption can also decrease vitamin C absorption, so keep an eye on your alcohol intake [69].

Over-the-counter (OTC) supplements (and many fortified foods) generally contain the synthetic form of vitamin C. However, no difference has been observed between comsuming synthetic and non-synthetic forms of vitamin C (such as ascorbic acid) [70]. Calcium ascorbate is another popular vitamin C supplement. Both ascorbic acid and calcium ascorbate are well absorbed.

For more information on vitamin C, read this SelfHacked post.

Vitamin D



Vitamin D2 and D3

Vitamin D has many functions in our bodies. It is perhaps most known for increasing calcium and phosphorus uptake in the small intestine, making it an important factor in optimal bone growth. In addition, vitamin D boosts immunity, brain health, muscle strength and performance; it also plays a role in insulin secretion and lowers blood pressure [71, 72].

Vitamin D can be obtained from food, supplements, or made in the skin. **Two different sources of vitamin D exist: vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol)**. Vitamin D2 is mostly consumed through fortified foods and supplementation. Vitamin D3 is made in the skin when our bodies are exposed to sunlight, and can also be taken in through our diet or by supplementation. Most of the vitamin D in food is in the form of D3, and some foods with the highest amounts of D3 include fish, meat, and eggs [12, 73].

Both forms of vitamin D (D2 and D3) are first converted to the inactive form of vitamin D (25-hydroxyvitamin D/calcifediol) in the liver, then transformed into the active form of vitamin D (1,25-dihydroxyvitamin D/calcitriol) by the kidneys. Both the inactive and active forms of vitamin D can be measured by blood tests -- however, the inactive form is more useful in determining our actual vitamin D status [74, 75].

The gene GC is responsible for producing the vitamin D binding protein (DBP), which binds to vitamin D in order to carry it throughout our bodies to where it is needed. Therefore, SNPs in the GC gene can impact how vitamin D is transported in our bodies. Five SNPs (rs7041, rs2282679, rs17467825, rs2298849, and rs12512631) have been shown to affect levels of vitamin D. CYP2R1 is the enzyme that is responsible for the first step in converting vitamin D to its active form and genetic variations for two SNPs (rs10741657 and rs1562902) have been associated with decreased levels of inactive vitamin D (25-hydroxyvitamin D). A second enzyme CYP27B1 is responsible for the second step of converting vitamin D into its active form. Certain genotypes for one SNP, rs10877012 in the CYP27B1 gene are associated with increased levels of inactive vitamin D (25-hydroxyvitamin D) [76, 77, 78, 79].

Vitamin D Related SNPs

SNP	Your Genotype	Associations	Reference
rs12512631	TT	Typical Levels of Vitamin D	78
rs1562902	CT	Slightly Increased Levels of Vitamin D	78
rs2282679	TT	Typical Levels of Vitamin D	76
rs2298849	AG	Slightly Increased Levels of Vitamin D	79

Your genotypes for the SNPs analyzed in this section indicate that you have an average risk of vitamin D deficiency. To reduce your risk of vitamin D deficiency, you may want to consider the following recommendations:

(1) Be sure to get enough sunlight each day, as this is a safe and effective way to increase the amount of vitamin D (specifically D3) created in your body [80].

(2) Consume higher amounts of vitamin D3, which you can get from fish (salmon and tuna), meat (beef and beef liver), and egg yolk. Studies have found vitamin D3 to be more effective than D2 at increasing vitamin D levels in the body. Vitamin D3 and vitamin K1 (and K2) work together in the body, so be sure to have enough vitamin K rich foods in your diet (K1: spinach, kale, broccoli, turnips, and edamame and K2: chicken, beef, and natto - fermented soybean) [81, 82, 83]. Finally, magnesium is important for vitamin D metabolism/activation, so make sure you are getting enough in your diet. It can be found in foods such as nuts, meats, and fish [84, 85].

(3) If you are not getting enough vitamin D from your diet, consider taking a vitamin D3 supplement. Vitamin D is fat-soluble, so be sure to take vitamin D supplements with a meal containing some fat.

(4) People with inflammatory gut conditions, such as Crohn's disease and celiac disease, can have a reduced ability to absorb vitamin D; so keep this in mind if you suffer from one of these conditions [86].

(5) Cigarette smoking and caffeine consumption can also decrease vitamin D levels, so consider reducing or quitting smoking and reducing the amount of caffeine you drink [87, 88].

Over-the-counter (OTC) supplements contain either vitamin D2 or D3. Vitamin D2 is the more common form that is found in most supplements and fortified foods. As stated previously, studies have found vitamin D3 to be more effective at increasing the body's levels of vitamin D [89, 81, 82], so if you are looking the best results, we recommend looking specifically for a supplement that contains vitamin D3. Cod Liver Oil contains high levels of vitamin D3, and it is an additional supplement option for those looking to increase their vitamin D3 intake. It would also be beneficial to monitor your levels using a tool such as the Lab Test Analyzer to make sure your levels are in the optimal range.

For more information on vitamin D, read these two SelfHacked posts: (1), (2).

Vitamin E

Tocopherols and Tocotrienols

Vitamin E is the most abundant antioxidant in our bodies, and also plays a role in immunity, blood pressure, and the prevention of blood clots. Vitamin E exists in **two major active forms: tocopherols and tocotrienols**. Vitamin E must be taken in by the diet or through supplementation, since our bodies cannot create it. Foods rich in vitamin E include vegetable oils, sunflower seeds, almonds, hazelnuts, leafy greens, and peanuts or peanut butter [90, 91, 13].

The gene ZPR1 produces the zinc finger one protein, which helps to activate other genes (transcription factors) involved in vitamin E use in the body. Another gene, CYP4F2, is responsible for producing a liver enzyme that breaks down (metabolizes) vitamin E. The gene SCARB1 is important for vitamin E transport throughout the body. Finally, the gene NKAIN3 is involved in allowing vitamin E to enter the cells that need it. Genetic variations for four corresponding SNPs in each of these respective genes (rs964184, rs2108622, rs11057830, and rs7834588) have been associated with increased vitamin E levels [92, 93, 94, 95, 13].

Vitamin E Related SNPs

SNP	Your Genotype	Associations	Reference
rs11057830	AG	Slightly Increased Levels of Vitamin E	93
rs2108622	CC	Typical Levels of Vitamin E	93
rs7834588	TC	Slightly Increased Levels of Vitamin E	96
rs964184	GC	Slightly Increased Levels of Vitamin E	93

Your genotypes for the SNPs analyzed in this section indicate that you have a slightly below-average risk of vitamin E deficiency. Nevertheless, we still recommend eating a balanced diet that includes sufficient amounts of vitamin E, which you can get from various vegetable oils, nuts (sunflower seeds,

almonds, hazelnuts, and peanuts), and leafy greens. Being in this risk category, vitamin E supplementation is not recommended; nonetheless, the following information provides valuble insight into vitamin E supplements for those that might not be getting enough in their diet.

Over-the-counter (OTC) supplements contain natural (i.e. alpha-tocopherol or d-alpha tocopheryl succinate) or synthetic vitamin E, (i.e any form whose name includes "dl-"). Additional products also exist that contain mixtures of both, however, the natural forms of vitamin E are better at raising levels in the body [97].

Vitamin K

Vitamin K1

Vitamin K exists in two main natural forms, vitamin K1 (phylloquinone) and K2 (menaquinones). *This section of the report will focus on vitamin K1 genetic polymorphisms. However, general information will be provided for vitamin K1 and K2.* Vitamin K1 is essential for blood clotting and vitamin K2 has important roles in the of strengthening bones and the prevention of blood vessel calcification (hardening). [98].

Vitamin K1 and K2 are both fat-soluble and dietary vitamin K1 comes from plant foods such as spinach, kale, broccoli, turnips, and edamame. Vitamin K2 can be created from vitamin K1 by bacteria found in the gut, and can also be found foods such as chicken, beef, cheese, and natto (fermented soybean) or through supplementation [99, 100, 101, 14].

Before our bodies can use vitamin K1 converted by an enzyme called VKORC1. This protein is the target of the widely-used anticoagulant drug warfarin (Coumadin, Jantoven) -- therefore, the SNPs associated with this protein are also useful in predicting warfarin sensitivity. People with genetic variations in the SNPs rs2359612, rs9923231, and rs9934438 have decreased levels of active vitamin K1 in the body. Vitamin K1 metabolism primarily involves the liver enzyme CYP4F2. Genetic variations for one SNP, rs2108622 has been associated with decreased breakdown (metabolism) of vitamin K1, which can lead to elevated active vitamin K1 levels [102, 103, 104].

Vitamin K1 Related SNPs

SNP	Your Genotype	Associations	Reference
rs2108622	CC	Typical Levels of Vitamin K1	104
rs2359612	AG	Slightly Increased Levels of Vitamin K1	105
rs9923231	TC	Slightly Decreased Levels of Vitamin K1	102
rs9934438	AG	Slightly Decreased Levels of Vitamin K1	103

Your genotypes for the SNPs analyzed in this section indicate that you have an average risk of vitamin K1 deficiency. To reduce your risk of developing a vitamin K1 deficiency, you may want to consider the following recommendations:

(1) Consume higher amounts of vitamin K1, which can be found in foods such as spinach, kale, broccoli, turnips, and edamame [83].

(2) If you are not getting enough vitamin K1 from your diet, consider taking a supplement. Vitamin K1 supplements should be taken with a meal that contains some fat for better results [106].

(3) Excessive alcohol consumption has been shown to decrease vitamin K1 levels, so watch your alcohol intake [107].

Over-the-counter (OTC) supplements generally contain either the natural form (phylloquinone) or the synthetic form (phytonadione) form of vitamin K1. Although your risk of vitamin K2 deficiency is unknown, we still recommend getting enough in your diet from foods including chicken, beef, cheese, and natto (fermented soybean). Supplements for vitamin K2 contain natural vitamin K2 in the form of menaquinone-4 (MK-4) or menaquinone-7 (MK-7), although MK-4 is better abosorbed [106].

For more information on vitamin K, read this SelfHacked post.

Conclusion

This ends your **SelfDecode DNA Wellness Report: Vitamins** -- we hope you found it interesting and insightful!

Some final points to keep in mind:

- **Remember that most vitamins depend on other vitamins**. In order to achieve optimal health, it is best to adopt a holistic and balanced approach. Maintaining proper levels of all of the essential vitamins is important for everyone. B vitamins, in particular, work synergistically (together), so be sure to get enough in your diet or through supplementation.
- **In general, it is we recommend the majority of vitamins be taken in through your diet, and supplements are to be used as a "backup plan"**. Supplementation should be considered when you are not getting enough vitamins in your diet, or if your vitamin requirements are higher due to factors such as deficiency, pregnancy and/or breastfeeding, or advanced age. When you consume vitamins through your diet, you are also taking in other nutrients and enzymes that help the body absorb and use vitamins.
- **If you are considering supplementation, non-synthetic (natural) vitamin sources are sometimes better than synthetic versions**. Consuming the natural, non-synthetic vitamin form is of greater benefit or safer when compared to synthetic forms for specific vitamins (vitamin B9, B12, and E). For other vitamins, no significant advantages have been found for the non-synthetic vs. synthetic forms (vitamin A and C).
- **Consume black pepper with meals to help with vitamin absorption.** Black pepper can increase the absorption of many nutrients including vitamins and minerals. Piperine, the active substance in black pepper can also be taken as a supplement. It also has many other beneficial properties, which you can read about here. Piperine can also increase absorption of medications, so be sure to determine if it can affect any medication you are taking.
- **Alcohol consumption and cigarette smoking have been shown to affect the levels of many essential vitamins in the body**. Consider lowering or removing either or both of these substances from your lifestyle to improve your vitamin status and overall health.
- **Certain groups of people require more vitamins than others**. Examples include women who are pregnant or breastfeeding (where folate is especially important) and elderly people (who tend not to absorb vitamins as efficiently with age). If you fall into either of these categories, be sure to keep an even closer eye on what you eat, and consider supplementation if you are not getting enough vitamins in your diet.
- **Many medications can affect the vitamin levels in the body**. If you are taking an over-the-counter (OTC) or prescription medication be sure to determine if it can affect vitamin levels in the body. In addition, check with your healthcare provider to see if there is an alternative available.

Prioritized Suggestions

The following is a prioritized list of all the suggestions made throughout your report. We have used your

SNP data to help us identify which might be most relevant to you.

Please keep in mind that we do not have information on the majority of genetic variations you carry, the environment you live in, and your lifestyle choices. As such, this list is not guaranteed to be 100% accurate. To help resolve this issue we will be releasing updated versions of our reports that include more SNPs, please check our reports page to see if there is a new report waiting for you.

1. **Ensure your diet contains sufficient amounts of vitamin A from both animal (retinoids: beef liver, salmon, and tuna) and plant (caretinoids: spinach, sweet potatoes, and carrots) sources.**
2. **Ensure your diet contains sufficient amounts of vitamin B9 (folate) from foods such as green vegetables.**
3. **If you are not getting enough vitamin A in your diet, consider taking a vitamin A (retinol not beta-carotene) supplement.**
4. **If you do not get enough vitamin B9 in your diet, consider taking a vitamin B9 supplement such as l-methylfolate.**
5. **Avoid excess alcohol consumption.**
6. **Avoid smoking cigarettes.**
7. **Avoid taking short acting antacids around meals.**

Please also note that everything we've presented here represents only a small sample of the information now available to you! **If you'd like to learn more**, we encourage you to:

- Use SelfDecode to explore your genetics further.
- Check out our DNA Wellness Reports page to learn more about the specialized reports we offer.
- Check back in with us to receive updated versions of the reports you have already purchased.
- Get in touch! We'd love it if you let us know how this report helped you improve your health, as well as what new information or features you would like to see in future versions.

In closing, please keep in mind that this report is not an official medical document, and should not be used to replace traditional medical practices. Also, it should not be used for the diagnosis or treatment of any disease/condition. Any health concerns you have should always be discussed with a licensed professional in the appropriate medical field (doctor, psychologist, nutritionist, etc.) before making any major medical decisions.

The science behind personalized genetics is rapidly growing, and is making new discoveries every day. **At SelfDecode, we are committed to staying on the cutting edge of all of the latest science**. This exciting field is constantly producing new findings and challenging existing ideas -- and for this reason we encourage all our readers to check back regularly as we continue to incorporate the latest findings into our Gene Reports! No report on the market will have 100% of all the existing scientific information, but we strive to provide the most comprehensive reports available. Email alerts regarding new versions of this report will be sent so you can continue to access the latest scientific information about your genetics and your health.

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