Chris Kresser
LET'S TAKE BACK YOUR HEALTH — *Starting Now.*

Why Vegetarians and Vegans Should Supplement with DHA

on **SEPTEMBER 13, 2016** *by* **CHRIS KRESSER** **215** *comments*

DHA is a crucial nutrient for developing babies, children, and adults, yet there are no sources of DHA in vegetarian or vegan diets. Some advocates of vegetarian diets have claimed that vegans can get enough DHA by consuming plant-based forms of omega-3 like flaxseeds and walnuts. But is that really true? Read on to find out.

A couple of weeks ago, Joe Rogan invited me to be a guest on his top-ranked podcast. Joe is a fantastic guy, a skilled interviewer, and knowledgeable about health and nutrition in his own right.

istock.com/richcarey

We covered a variety of topics, including Paleo and vegetarian/vegan diets; Big Pharma, Big Food, and Big Science; functional vs. conventional medicine; and the importance of lifestyle and behavior change.

One of the particular issues we discussed related to vegetarian and vegan diets was the importance of long-chain omega-3 fats like EPA and DHA. I summarized research indicating that vegetarians, and particularly vegans, have lower levels of EPA and DHA than omnivores and that plant-based omega-3 fats like flaxseed and walnuts are not adequate sources of EPA and DHA in most cases. I argued that most vegetarians and vegans will need to supplement with preformed DHA—from microalgae, for example—in order to ensure adequate levels of these important fatty acids. I stand by this claim, and, as you'll see below, the evidence clearly supports it.

What I got wrong on the show was that vegans need to take several capsules of microalgae supplements in order to meet their daily DHA needs. In fact, with most microalgae products on the market today, vegans can take one or two capsules a day to meet that need. I was basing the larger number of capsules on a higher target of DHA per day that I previously recommended, but I have since revised my view on based on new research suggesting potential harm from too much omega-3 fat. That's an important difference, and **I apologize for any confusion it may have caused.**

One final note before we dive in. As I said numerous times on the show, I am not arguing that it's not possible to be healthy on a vegan diet. Spectacular athletes like Rich Roll demonstrate that it is. My argument is that 1) there is a higher risk of nutrient deficiencies on a vegan diet (including DHA, the subject of this article), especially without smart supplementation, and 2) there are numerous factors that determine whether one becomes nutrient deficient on a vegan diet, which explains the wide range of responses. If someone is going to commit to a vegan diet, these are the facts they need to be aware of in order to increase their chances of success.

DHA and vegans in a nutshell

This is going to be a long article filled with a lot of scientific references because I want to provide a comprehensive summary of what the research says on this topic. But I also want to make it accessible to people who aren't scientists or healthcare professionals. I'm going to summarize the key takeaways right up front, and then I'll go into further detail on each of them below.

Here's the 30-second summary:

- In all but one study I've seen, **omnivores have the highest DHA levels**, followed by vegetarians, followed by vegans.
- **Conversion of ALA to EPA and DHA is inefficient**: less than 5 to 10 percent for EPA and 2 to 5 percent for DHA.
- Even those low numbers may be optimistic because most studies show that **supplementing with plant-based forms of omega-3** (alpha-linolenic acid, or ALA) like flaxseed oil **does not increase serum or breast milk levels of DHA**.
- The conversion of ALA to EPA and DHA is **inhibited by linoleic acid (plant-based omega-6), nutrient deficiency, genetics, health status, and sex**. This may explain why ALA is a sufficient source of DHA for some vegetarians and vegans, but not for others.
- **DHA plays a crucial role in fetal and childhood brain development** (affecting visual acuity, intelligence, problem solving, etc.), and a growing body of evidence shows that **adults that consume higher amounts of DHA have lower risk of many diseases**, including cognitive decline, Alzheimer's disease, depression, schizophrenia, psychosis, and other behavioral disorders.
- Therefore **most vegetarians and vegans should supplement with preformed DHA** to ensure adequate levels of this crucial fatty acid.

Omnivores have higher levels of DHA than vegetarians or vegans

Numerous studies have shown that, on average, omnivores have higher levels of DHA than vegetarians and vegans, with vegans at the bottom of the scale. For example, one study in 196 meat-eating, 231 vegetarian, and 232 vegan men in the United Kingdom found the following EPA and DHA levels, by group (1; see Table 2):

EPA levels (mg/L):
Omnivores: 0.72
Vegetarians: 0.52
Vegans: 0.34

DHA levels (mg/L):
Omnivores: 1.69
Vegetarians: 1.16
Vegans: 0.7

Lest you think this effect is limited to white males in the UK, similar results have been found in studies of Austrian, Dutch, Australian, Finnish, Chinese, and US adults. (2, 3, 4, 5, 6, 7, 8) The authors of the Austrian study noted that vegetarian diets promote "biochemical tissue decline" and that vegetarians and vegans "should supplement with preformed EPA and DHA, regardless of age and gender." (2)

This leads to three conclusions:

- There is less EPA and DHA in the typical vegetarian and vegan diet than in an omnivorous diet
- Vegetarians and vegans are not converting ALA into EPA and DHA at a rate sufficient to match the serum DHA levels of omnivores
- Vegetarians and vegans are either not supplementing with DHA at all, or they are not taking enough, since their blood levels are lower than those of omnivores

Why do vegetarians and vegans have lower levels of DHA than omnivores?

Now that we've established that vegans and vegetarians have lower levels, on average, of DHA than omnivores, let's explore why this is the case. There are two primary reasons:

1. Lower intake
2. Reduced conversion

Lower intake

This one is quite simple: EPA and DHA are found almost exclusively in animal foods. Seafood and marine oils are the primary source, but pasture-raised meat and dairy products (and, to a lesser extent, conventionally raised meat and dairy) also contain modest amounts. The only significant source of preformed DHA in plant foods is microalgae (which is why most vegan DHA supplements are made from it). (9)

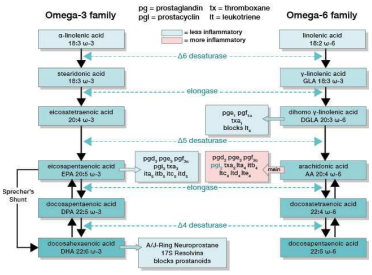
Reduced conversion

This one requires a bit more explanation, but it's crucial to understand, so please bear with me.

A fatty acid is a chain of carbon, oxygen, and hydrogen atoms with a carboxyl group on one end. Fatty acids are classified on the basis of how many carbon atoms are in the chain, as well as how many double bonds exist within the molecule.

As you can see from the chart below, it is also possible for the body to synthesize EPA and DHA from the short-chain omega-3 alpha-linolenic acid (ALA). ALA is found in plant foods such as flax, hemp, and pumpkin seeds and walnuts.

Eicosanoids



Adapted from Das UN. Biotechnol J. 2006 Apr;1(4):420-39

Looking at this chart, it's easy to see why a vegetarian or vegan might assume that they can meet their DHA needs simply by consuming flaxseeds and walnuts.

However, research indicates that the conversion of ALA to EPA and DHA is inefficient and extremely limited. Less than 5 to 10 percent of ALA gets converted to EPA, and less than 2 to 5 percent gets converted to DHA. (9)

Even these low conversion rates may be a best-case scenario, especially in the case of DHA. Why? Because ALA supplements have little effect on blood or breast milk DHA levels in adults, and although adding ALA to infant formula does raise DHA in babies, it doesn't raise it to the level that babies get from consuming breast milk. (10)

This is hugely important because, as we'll see below, DHA is an essential nutrient for fetal brain development, and low maternal DHA levels are associated with lower IQ and visual acuity and suboptimal brain development.

Another important point to understand is that a wide variety of factors—some of which are common in people following a vegetarian and vegan diet—may further inhibit the conversion of ALA to DHA. Studies have shown that the conversion of ALA to EPA and DHA is inhibited by linoleic acid, nutrient deficiency, genetics, health status, and sex. (11, 12) Let's look at each of these in turn.

Linoleic acid

Linoleic acid (LA) is a plant-based omega-6 fat, found in things like nuts and seeds, avocados, and industrial seed oils used in virtually all packaged, processed, and restaurant foods. Studies have shown that vegetarians and vegans have a high intake of LA compared to ALA—an average ratio of 10:1—which would impair conversion of ALA to DHA. (2) In addition, a large proportion of dietary ALA is oxidized, and thus unavailable for conversion into DHA. (13)

Recent research suggests that the optimal conversion of ALA to DHA occurs at a ratio of LA to ALA of 1:1. (14) However, reducing LA intake that significantly is extremely difficult to achieve when following a vegetarian or vegan diet. Other studies have shown that a ratio of between 2 and 4:1 may still allow for adequate conversion, but note that this is still significantly lower than the average omega-6 to omega-3 ratio of 10:1 for vegetarians and vegans. (2, 15)

Nutrient deficiency

If you look back at the chart above, which demonstrates the conversion pathways of essential fatty acids, you'll see that there are several important enzymes in that pathway: delta-5-desaturase, elongase, and delta-6-desaturase. Like all enzymes, these require certain nutrients as cofactors in order to function properly. These include vitamins B3 and B6, vitamin C, magnesium, calcium, selenium, iron, and zinc. (16, 17, 18, 19)

As I've written elsewhere, vegetarians and particularly vegans are at higher risk of deficiency of some of these nutrients—especially iron. Vegetarians and vegans have lower iron stores than omnivores, and vegetarian diets have been shown to reduce nonheme iron absorption by 70 percent and total iron absorption by 85 percent. (20, 21)

This suggests that deficiencies in vegetarians/vegans of nutrients that are required for optimal conversion of ALA to DHA may further explain why their levels of DHA are lower than omnivores.

Genetics

Delta-5- and delta-6-desaturases are encoded respectively by the FADS1 and FADS2 genes. Recent research has shown that different FADS1 and FADS2 genotypes are associated with significant differences in DHA levels. (24) This shouldn't be surprising, since, as you now know, the delta-5- and delta-6-desaturases play an important role in the conversion of ALA to DHA. A variety of other genes have been shown to affect this conversion as well. (18)

Quite simply, this means that there are genetically determined individual differences that affect the rate of conversion of ALA to DHA. This could explain why some vegans are able to maintain higher levels of DHA without supplementation than are others.

Health status

Studies have shown that the delta-5 and delta-6 conversion enzymes don't function as well in people with diabetes, metabolic syndrome, hypertension, or certain metabolic disorders. (16, 18) Like genetics, differences in health status can influence individual conversion of ALA to DHA and may explain some of the variation observed in vegetarians and vegans.

Sex

Finally, it appears that young women convert significantly more ALA to DHA than young men. The most likely explanation is that this is nature's way of ensuring adequate levels of DHA in pregnant and lactating women, which, as you will see below, is crucial to the health of the developing baby and child.

One study showed that women converted 21 percent of ALA to EPA and 9 percent to DHA, whereas men converted 8 percent of ALA to EPA and 0 percent for DHA. (25) Yes, you read that correctly: zero percent conversion in men. This led to an average conversion of ALA to DHA in men and women combined of 4.5 percent, but obviously that average doesn't tell the whole story. This may explain why, anecdotally at least, men don't do as well on vegan diets as women.

Why is DHA so important—and how much do we need?

The importance of DHA in the diet has been widely covered in both the mainstream media and the scientific literature for the last two decades. DHA is an essential nutrient for fetal brain development, and low maternal DHA levels are associated with lower IQ and visual acuity and suboptimal brain development. (26, 27, 28, 29, 30, 31)

Some studies argue that the lower DHA levels observed in vegetarians and vegans do not constitute overt deficiency and that evidence of harm is limited. Vegans have used this as an argument that DHA supplementation isn't required.

However, a growing body of evidence suggests that even adult requirements for DHA may be higher than currently recognized and that adults who consume higher amounts of DHA have lower risk of cognitive decline, Alzheimer's disease, cardiovascular disease, depression, schizophrenia, psychosis, and other behavioral disorders. (32, 33)

This shouldn't be surprising, given that the RDA for each nutrient is the amount required to avoid deficiency symptoms—not the amount required to promote optimal health, which is often much higher than the RDA. There are numerous examples of where the RDA is likely insufficient for promoting optimal health—such as zinc, iron, and B12—and given the research above, DHA seems to be another.

But how much DHA do we need? Recommendations vary widely depending on the country and organization, ranging from 100 mg/d on the low end to 300 mg/d on the high end. Based on research linking DHA with all of the benefits mentioned above, a panel of experts at the National Institutes of Health (NIH) recommended a daily intake of EPA and DHA combined of 650 mg/d, with at least one-third of that amount (approx 215 mg/d) coming from DHA. (34)

In theory, with a conversion rate of 2 to 5 percent of ALA to DHA, this means vegans and vegetarians would need to consume between 4.3 and 10.8 grams of ALA per day to produce 215 mg/d of DHA, depending on where they fall in the conversion spectrum.

How does that compare to the average intake of ALA in the United States? According to a study of more than 14,000 men and women in the US, the intake of ALA is 0.97 g/d in vegetarians and 0.86 g/d in vegans. (35) This is obviously well below the range needed to produce 215 mg/d of DHA.

Some vegans have argued that even the higher dose of 10.8 grams of ALA per day is easily obtainable simply by taking a tablespoon of flaxseed oil. However, as I mentioned earlier in the article, most studies show that supplementing with ALA does not increase DHA levels in the serum or breast milk, so it seems that in many cases flaxseed oil will not solve the problem. (10, 36)

Given the high intake of LA and low or nonexistent intake of EPA and DHA in vegetarians and vegans, it wouldn't be surprising to see low tissue levels of EPA and DHA in these populations. That's exactly what research shows. For example, one study found that EPA levels of vegans were only 12 to 15 percent and DHA levels were 32 to 35 percent of those of omnivores. (37) Another study found that EPA levels in vegans were only 22 percent of those of omnivores, and DHA levels were 38 percent of those of omnivores. (38) Finally, and most concerning, a study found that vegan infants had less than 30 percent of the EPA and DHA of omnivorous infants. (39)

Conclusions

I started with the conclusions of the article in the introduction, but let me review them again here:

- Vegetarians and vegans have lower levels of EPA and DHA than omnivores. This indicates that they aren't getting enough ALA in their diet to produce sufficient DHA and that most vegetarians and vegans aren't supplementing with preformed DHA.
- The conversion of plant-based forms of omega-3 found in foods like flax seeds and walnuts into EPA and DHA is inefficient.
- Supplementing with ALA (e.g., flaxseed oil) does not adequately increase serum or breast milk levels of DHA.
- DHA is crucial to human health during gestation, childhood, and adulthood.
- Therefore, most vegetarians and vegans should supplement with preformed DHA to maintain optimal blood levels.

This is especially true for populations with higher DHA requirements, like pregnant and lactating mothers, and in those with poor conversion, like men, people with nutrient deficiencies, and people with chronic illness. As discussed in the article, ALA supplements like flaxseed oil aren't sufficient in most cases, and supplementation with preformed DHA is necessary for maintaining optimal blood DHA levels.

The best option for those unwilling to consume seafood is a microalgae supplement. Algae is the base of the food chain for fish, and it is rich in DHA. (DHA can be retro-converted to EPA, so it is not necessary to supplement with EPA separately.) Most products on the market contain about 200 mg of DHA per capsule, so a dose of one to two capsules per day would suffice.

For those who are not vegetarian or vegan, however, the best option is to simply eat 12 to 16 ounces of cold-water fatty fish per week. This not only provides adequate amounts of preformed EPA and DHA, but it also provides highly bioavailable protein and other nutrients like selenium that are important to health. Although I've written extensively about why concerns about mercury in most fish species are overblown (here, here, and here) and why the benefits of eating fish far outweigh the risks, if you're concerned, you can simply choose low-mercury species (which is what virtually all public health organizations recommend). And contrary to what some have claimed, dioxins and PCBs are not a significant health concern when it comes to seafood consumption.

I'll close by recognizing that there are many reasons why people choose to go vegetarian or vegan. Some are compelled by the environmental impact of confinement animal feeding operations (CAFO). Others are guided by ethical concerns or religious reasons. I respect these reasons and appreciate anyone who thinks deeply about the social and spiritual impact of their food choices—even if my own exploration of these questions has led me to a different answer.

If you do choose a vegetarian or vegan diet for yourself and/or your children, understanding how to mitigate any possible adverse effects of that choice—in this case, suboptimal intake of DHA—will maximize your chances of success and minimize your chances of harm. I hope that this article serves that purpose.

AFFILIATE DISCLOSURE